New Nature Economy Reports series

WORLD ECONOMIC FORUM

Seizing Business Opportunities in China's Transition Towards a Nature-positive Economy

INSIGHT REPORT

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Foreword

Gim Huay Neo (梁锦慧), Managing Board, Managing Director, Centre for Nature and Climate, World Economic Forum, Geneva, Switzerland

Zhu Chunquan (朱春全), China Head, Centre for Nature and Climate, World Economic Forum, Beijing, China

Climate, food, biodiversity, livelihoods and communities are inextricably intertwined. To effectively address the nature and climate emergency, we need to adopt a holistic and integrated approach and transform systems at scale.

These interconnections, along with a call for collaborative action, were emphasized at the key United Nations milestone events of the past year, including the UN Food Systems Summit, the COP 26 of the UN Convention on Climate Change and the first phase of the COP 15 of the UN Convention on Biological Diversity.

The nature and climate emergencies are underscored by the 2022 edition of the World Economic Forum's flagship *Global Risks Report*, which identifies climate action failure, extreme weather events, and biodiversity loss and ecosystem collapse as the top three most severe risks in the next decade.

The *New Nature Economy Reports* (NNER) series by the World Economic Forum seeks to explain why nature-related risks matter to business, which transitions are needed to move towards a nature-positive economy and how business can be a part of the solution, paving the way to create new opportunities and generate sustainable value.

Our analysis has shown that over half of the world's GDP is moderately or highly dependent on nature and its related ecosystem services and at risk of severe disruption, with dire consequences for societies and economies alike. Notably, there will be disproportionate implications for the Asia-Pacific region, especially among emerging economies. An estimated 42% of all biodiversity in Southeast Asia could be lost by 2100, half of which would be global extinctions, according to the Asia-Pacific deep dive of the NNER series: *Asia's Next Wave.*

This report takes a close look at China, the world's second largest economy and one of the most biodiverse countries in the world. Four decades of rapid economic growth and urbanization have unfortunately come at a cost to the health of natural ecosystems.

The Chinese philosophy of an "ecological civilization" puts forward a compelling vision of a beautiful China where development exists in harmony with nature and promotes environmental protection. This is enshrined in China's *14th Five Year Plan and Vision for 2035*. In line with this vision, in 2020 China has also set ambitious climate goals: to peak emissions before 2030 and achieve carbon neutrality before 2060.

This report makes the case that to realize the vision of sustainable development, addressing the issues of emissions and climate change will not be sufficient. It is equally important and urgent to address other drivers of biodiversity loss and environmental degradation, including land use and pollution.

Businesses have a key role to play in a carbon-neutral and nature-positive future. Our study shows that 15 priority transitions have the potential to add $1.9 trillion in annual business value and create 88 million jobs by 2030 in China.

Businesses who choose to act today will build resilience and capabilities, creating a sustained competitive advantage. This is good for the planet, for business and for society.

Embarking on these transition pathways will, however, not be easy. Everyone must get involved, with citizens, businesses and investors partnering the Chinese government.

Guided by the philosophy of an ecological civilization, China is paving the way towards building a green, low-carbon, circular economic system. The World Economic Forum's China team is eager and ready to work with companies and institutions that are prepared to be champions for nature, to translate the insights from this report into reality and move from ambition into action.

Together, we can build a nature-positive future for China by 2030 and an ecological civilization for current and future generations.

Preface

Johan Rockström, Professor of Earth System Science, University of Potsdam and Director, Potsdam Institute for Climate Impact Research

China, the world's second largest economy, is uniquely placed to lead the global transition towards a nature-positive, net-zero and equitable world, as this report shows. *Seizing Business Opportunities in China's Transition Towards a Nature-positive Economy* provides Chinese businesses with a clear roadmap towards this future. It demonstrates how businesses and policy-makers in China can work together to break silos and become an example for businesses and governments everywhere.

Action must start now. Like all major economies, China's development has come at the expense of the stability of Earth's life-support systems. Scientifically, we have recently identified between 15 and 20 major systems that regulate Earth's climate and nature. These systems include the world's glaciers and ice sheets, rainforests and boreal forests, and functioning ocean currents. I call them the new "global commons" in the Anthropocene.

At the current level of global heating, three of these critical systems are at high risk of crossing tipping points to an unstable, self-reinforcing state: Arctic summer sea ice, the West Antarctic Ice Sheet (WAIS) and the tropical coral reef systems. Humanity is now in a danger zone. We are taking colossal risks with our future. The world has transgressed scientifically-defined planetary boundaries. Within these boundaries is a safe operating space for humanity (and our economies). Beyond these boundaries lurk risk and danger.

Navigating towards a safe operating space requires a holistic view of environmental challenges. Nature may be China's strongest ally in fighting climate change, as this report argues. Climate change and biodiversity loss are two sides of the same coin. By keeping nature intact and building ecological resilience, we not only ensure better delivery of ecosystem services for humans, we also enhance Earth's cooling capacity – an essential insurance policy for our planet.

China's vision to become an "ecological civilization" is now written into its constitution. This is good news for China and for the world. The foundation of such a vision must be to build a nature-positive economy: an economy in harmony with Earth, indeed, an economy that drives emissions down, improves soil health, purifies air and water, and supports a rich diversity of life. This report is an important first step along this path.

Justin Yifu Lin (林毅夫), Member of the Standing Committee and Deputy Director, Economic Committee of the National Committee of the Chinese People's Political Consultative Conference; Professor and Honorary Dean, National Development Institute; and Dean, Institute of New Structural Economics, Peking University, Beijing

China's economic development has entered a new phase. The focus has shifted from simply pursuing growth to improving the quality of growth. President Xi Jinping has emphasized that to achieve high-quality development, China must implement a new paradigm based on the principles of "innovation, coordination, green, openness and sharing". The President's philosophy that "lucid waters and lush mountains are invaluable assets" highlights the importance that China places on the sustainability of the country's ecosystems and natural resources in the journey towards high-quality development.

The construction of an "ecological civilization" through green, low-carbon development has become a consensus widely shared across Chinese society. China is actively addressing climate change through the establishment of its "dual carbon goals" – to peak carbon emissions before 2030 and to achieve carbon neutrality before 2060. However, tackling climate change is inextricably linked to goals such as reversing biodiversity loss and ensuring food security. It is more efficient and cost-effective to approach these issues in a holistic manner.

Advancing these goals simultaneously presents both a unique opportunity and an unprecedented challenge for China. This report by the World Economic Forum emphasizes the vital importance of environment, ecology and natural resources, and how directly linked their ecosystem services are to China's economy. It analyses transitions in three socio-economic systems, closely connected to nature, that account for two-thirds of China's total GDP.

Humans are part of nature, and it is human nature to want to improve our livelihoods and well-being. We have an obligation to protect, restore and improve nature's ecosystems, by redirecting economic development away from a simplistic focus on quarterly returns and GDP towards a sustainable path that respects biodiversity and natural capital. There is an opportunity for Chinese policy-makers, market players and wider stakeholders to collaborate and engage in joint global action towards achieving high-quality economic development within the parameters required to preserve biodiversity and combat climate change.

Zhang Jianqiu (张剑秋), Chief Executive Officer, Inner Mongolia Yili Industrial Group Co., Ltd.

Addressing climate change and protecting biodiversity require global consensus and collective action. This report suggests that nature loss will disrupt business operations and supply chains, as well as increase regulatory and compliance risks, market risks and reputational risks for companies. Increasing numbers of businesses in China are realizing that they should adopt a proactive approach towards environmental management and protection in their long-term strategic development.

As the first Chinese company to sign the UN's Business and Biodiversity Pledge, Yili Group has made significant efforts towards implementing the pledge's nine commitments, by promoting the sustainable use of resources, energy conservation and emission reductions in production, while actively encouraging partners along the value chain to adopt sustainable practices.

Alongside China's double carbon goals, this report highlights the importance of embracing a nature-positive target that aims to reverse nature loss by 2030 and restore natural ecosystems towards full recovery by 2050. To realize this goal, the report proposes 15 nature-positive transitions that could add $1.9 trillion in annual business value to China's economy and create 88 million new jobs by 2030. Seizing these new business opportunities will enable companies to reap commercial benefits while contributing towards biodiversity conservation. Long-lasting business prosperity cannot be achieved without taking responsibility for protecting nature.

We look forward to working with partners from all industries to explore the win-win solutions for ecological protection and industrial development, to promote responsible production and consumption, and to make unremitting efforts for a better future in which people and nature live together in harmony.

Wang Yi (王毅), Member of the Standing Committee, National People's Congress; Vice Chair, National Expert Panel on Climate Change, People's Republic of China; Vice President, Institute of Science and Technology for Strategic Consulting, Chinese Academy of Sciences

The world is facing the interlinked challenges of climate change and biodiversity loss. China, as the largest developing economy, is pursuing a more balanced, resilient and high-quality sustainable development model, in which a green and low-carbon transition is the top priority.

China started to address its environmental issues in the 1980s, and has gone through a journey from initial treatment after pollution, to large-scale systemic treatment, to the stage of building an ecological civilization today. China's energy system, environment, society and economy are all undergoing systemic transformation to improve methods of production, consumption, distribution and trade. The green transformation of many industries, including agriculture, forestry, animal husbandry and fisheries, is fast accelerating, driven by new technological advancements and economic growth. The philosophy of ecological civilization provides an over-arching guiding framework for concerted efforts to achieve carbon neutrality and a nature-positive economy in China.

China's ecological civilization and "dual carbon" strategy were based on top-down approach. Each action is underpinned by a comprehensive set of theories, pilots and policies. This report is an important first step to identify China's priority transitions and business models, summarize China's relevant policies and highlight progress to date, case studies. The report also provides recommendations for Chinese businesses and government to accelerate the nature-positive transition and support China's participation in global governance and international cooperation on nature and biodiversity.

To achieve carbon neutrality and develop a "new nature economy", China will embark on a systematic and structural transformation over the next few decades which will bring many opportunities and challenges. This is not an easy task. China, like other countries, will learn by doing. Collaboration across government departments, coordinated target setting, planning and policy implementation, and the support from multi-stakeholder actors domestically and internationally are essential to achieve this vision.

Executive summary

China's natural ecosystems are facing challenges

Since the reforms and opening-up of the economy in the late 1970s, China has achieved remarkable economic success. In 2010, China became the world's second-largest economy. It has markedly improved its citizens' lives and succeeded in building a moderately prosperous society. The past four decades have seen 700 million people lifted out of poverty, with the urbanization rate increasing from 18% in 1978 to 63.9% today. Average annual income per capita increased from $120 in 1978 to $9,000 in 2019.

As one of the most biodiverse countries on earth, China is home to unique ecosystems, species and genetic variety, accounting for 10% of global plant species and 14% of animal species. Yet fast economic growth and rapid urbanization rates have taken their toll on China's natural ecosystems. The mangrove area has declined by 40% since 1950, while one-third of grasslands are moderately or severely degraded and 21.4% of vertebrates are threatened.

Nature loss puts two-thirds of China's GDP and social development at risk

By 2020, China's middle class reached more than 400 million people and is projected to reach 600 million by 2030, representing over 40% of the country's total population. If urbanization continues to climb at a rate of 1% per year, it could exceed 70% by 2035. China already accounts for over 20% of the world's total energy consumption and this looks set to rise. With the growing middle class, changes in consumer behaviour and burgeoning urbanization, the old unsustainable industrialization model of "high input, high energy consumption, high pollution, low output", along with resource-intensive and wasteful consumption patterns, will place enormous strains on China's natural ecosystems, driving them to the brink of irreversible tipping points.

Natural ecosystems and their services are at the centre of China's economic growth, business prosperity and social development. Using the same framework as the Forum's *New Nature Economy Report II: The Future of Nature and Business*,

"$9 trillion of China's annual economic output is dependent on nature and its services, representing 65% of total GDP

Key findings at a glance

65% of China's total GDP is at risk of disruption through nature loss

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The growing middle class, changes in consumer behaviour, burgeoning urbanization and a business-as-usual economic development trajectory will place enormous strains on China's natural ecosystems

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China is in a unique position to lead the transition to a nature-positive, net-zero and equitable economy. As the host of the UN Convention on Biological Diversity's COP15, China is key to promoting the global consensus on the post-2020 Global Biodiversity Framework.

Chinese businesses are global leaders in the innovation and manufacturing of net-zero, nature-positive enabling technologies. Furthermore, China is fully committed to the principle of "ecological civilization" and has strengthened its biodiversity conservation as a national strategy.

The World Economic Forum's New Nature Economy Reports series comes out with a China deep-dive highlighting that 15 nature-positive business transitions could **create $1.9 trillion of annual business opportunities and 88 million jobs by 2030**.

this report finds that $9 trillion of China's annual economic output is dependent on nature and its services, representing 65% of total GDP. Nature loss has an a direct on the operations of businesses and their supply chains. Businesses also face regulatory, legal, reputational, market and other risks related to nature. In addition, collapses of natural ecosystems bring risks related to public health, migration, trade relations, material supply security and other social problems.

Climate change and biodiversity loss are two sides of the same coin

The World Economic Forum's *Global Risks Report 2022* lists "Biodiversity loss and ecosystem collapse" as one of the top three risks in the coming decade.[1] Biodiversity loss is closely linked to climate change. While climate change is responsible for between 11% and 16% of global biodiversity loss, agriculture, forestry and other land-use change are responsible for 23% of greenhouse gas (GHG) emissions globally, while agricultural expansion is the main driver for habitat loss and a major threat to biodiversity.

While securing China's targets to peak carbon dioxide emissions and achieve carbon neutrality will contribute to halting biodiversity loss, this will not be enough. The operations and supply chains of businesses have wider and longer-lasting impacts on nature than simply carbon emissions, whether through expanding land use, overexploiting organisms or emitting pollution. On the other hand, nature may be China's strongest ally in fighting climate change. According to latest estimates, the carbon storage potential of China's terrestrial ecosystem (comprising forest, shrubland, grassland and cropland) totals 80 billion tonnes, around eight times the country's total carbon emissions in 2019. Of this storage potential, 83% rests in the soil.

Facing these intertwined crises of biodiversity loss and climate change, China has put forward the "ecological civilization" concept of living in harmony with nature and has strengthened biodiversity conservation as a national strategy.[2] In 2021, the delineation of the "ecological conservation red line" was completed, protecting at least 25% of the country's land area. China has also set one of the most ambitious climate goals in the world: it aims to hit peak emissions before 2030 and reach carbon neutrality before 2060. However, over the last decade, while political momentum towards addressing the climate crisis has been rising globally, the issue of nature loss has often been perceived as a separate second-priority issue. China is in a unique position to break the siloes separating climate and nature and strengthen the integration of its dual carbon goals with its biodiversity targets, through championing the transition to a nature-positive development pathway.

Urgent transitions in three key socio-economic systems can achieve nature-positive economic development

The COVID-19 crisis has dealt a heavy blow to the global economy. As the Chinese economy recovers and continues its high-quality and stable growth, economic development must be linked to the deeper and wider global priorities of a stable climate and resilient biodiversity.

Three key socio-economic systems must take the lead in transforming their development pathways towards a carbon-neutral, nature-positive future (see Table 1):

- Food, land and ocean use
- Infrastructure and the built environment
- Energy and extractives

TABLE 1: **Three socio-economic systems and 15 transitions**

Food, land- and ocean-use system

1. Ecosystem restoration and avoided land-use and ocean-use expansion
2. Productive and regenerative agriculture
3. Healthy and productive oceans
4. Sustainable forest management
5. Planet-compatible consumption
6. Transparent and sustainable supply chains

Infrastructure and built-environment system

1. Compact built environment
2. Nature-positive built-environment design
3. Planet-compatible urban utilities
4. Nature as infrastructure
5. Nature-positive connecting infrastructure

Energy and extractives system

1. Circular and resource-efficient models for materials
2. Nature-positive metals and minerals extraction
3. Sustainable materials supply chains
4. Nature-positive energy transition

These three systems are inextricably associated with biodiversity threats, but also are crucial to China's economic and social development. **This report lays out a clear roadmap for Chinese companies to seize the business opportunities offered by 15 priority transitions under these three socio-economic systems. These transitions are projected to add $1.9 trillion in business value and could create 88 million jobs in China by 2030.** This represents over 20% of the global nature-positive business opportunities ($10 trillion) and employment growth (395 million), making China one of the most significant contributors to the global transformation.

Food, land- and ocean-use system

This system provides the food and clothing that sustain humans in their daily lives and is crucial for the livelihoods of millions of people. China has made astounding progress in agricultural production. Unfortunately, as its population increases, the growing demand of middle- and high-class consumers for food and clothes, rising urbanization rates and the expansion of agricultural land are all exerting growing pressure on this system. China is one of the countries most severely impacted by desertification and land degradation. Desertification now encompasses 27% of its land area. Middle- and low-yielding cropland accounts for two-thirds of the total arable land area. Yet the efficiency of the food supply chain in China has huge room for improvement – nearly 27% total food produced for human consumption in the country is wasted and lost.

The six complementary transitions outlined in Table 1 can together steer this system on a pathway towards nature-positive development. The business opportunities associated with these six transitions could create almost $565 billion of additional revenue while creating 34 million new jobs in China by 2030.

Infrastructure and built-environment system

Around three-quarters of the Chinese population will be living in cities by 2030, up from 63.9% in 2020. Unfortunately, extensive urban development exacerbates "urban diseases" such as environment pollution, ecological destruction and traffic congestion in surrounding areas. These impacts have exacted a heavy toll on the physical and mental health of urban residents. Meanwhile, as China accelerates the construction of connecting infrastructure, such as roads, railways and ports, this may have an adverse effect on the surrounding ecological environment and damage or even destroy fragile ecosystems.

As China makes progress in its socio-economic development and urbanization, five complementary transitions outlined in Table 1 can steer its infrastructure and built environment on a pathway towards nature-positive development. The business opportunities associated with these transitions could create around $590 billion of additional revenue and 30 million new jobs in China by 2030.

Energy and extractives system

China is the largest energy producer and consumer in the world. In 2019, China's energy consumption growth accounted for three-quarters of the world level, while its energy consumption per unit of GDP was 1.5 times the world average. In China, the much-needed energy transition to cope with climate change requires installing more renewable energy, including wind and solar, but this too may cause pollution as well as encroaching on and fragmenting animal habitats. For example, the rising demand for power storage – in the form of electric vehicle batteries – may lead to a significant increase in the demand for some metals, further intensifying the exploitation of natural resources and land-use change.

Reversing these negative impacts involves improving the energy efficiency of both production and consumption, to reduce the extraction demands for new resources. In addition, improving how those resources are extracted is vital to minimize the impact of extraction on ecosystems. The four critical transitions of the energy and extractives system are outlined in Table 1. Together, the business opportunities associated with these transitions could create almost $740 billion of business value while creating 23 million new jobs in China by 2030.

Tea plantation in China

GETTY/XIJIAN

Four steps to set China on a nature-positive pathway

China is in a unique position to lead the transition to a nature-positive, net-zero and equitable economy. As the host of the UN Convention on Biological Diversity's COP15 conference, China is key to promoting the global consensus on the post-2020 Global Biodiversity Framework. Chinese businesses are global leaders in the innovation and manufacturing of multiple technologies such as drones, 5G, power batteries and solar photovoltaic panels, all of which are crucial enablers in the nature-positive transition. Furthermore, alongside the pursuit of achieving its ambitious climate targets, China is also updating and further clarifying its biodiversity strategy and objectives. There is huge impact to be realized if the climate and biodiversity targets can be integrated with China's green, low-carbon circular economic development goals.

As we enter a historic decade of action to bend the curve of biodiversity loss and address climate change, scientists, policy-makers and business leaders must join forces to take concrete actions now. This vision requires global consensus and collective effort, ambitious policy and stringent regulation, technology and innovation, as well as public and private funding.

1. **Promote global consensus, raise ambition and strengthen collaboration:**
   Chinese government and businesses need to deepen their engagement in global biodiversity governance and negotiations, and strengthen cooperation between the developing and developed world. The $233 million Kunming Biodiversity Fund committed by the Chinese government to help developing nations protect nature is a first step. Furthermore, China can establish global leadership by raising its political will and encouraging Chinese businesses to make voluntary commitments and increase investments in their own nature-positive transitions. Lastly, collaboration among players along global value chains is imperative to enhance transparent and traceable supply chains and drive sustainable change.

2. **Drive policies and regulatory changes:**
   In the process of constructing the "1+N" policy packages to achieve its dual carbon goals, the Chinese government needs to mainstream and scale-up nature-based solutions as a key component of its climate policies. The Chinese government can also promote the concept of "gross ecosystem product" (GEP) and put forward conducive financial policies and incentive mechanisms to encourage green production and consumption. Finally, China needs to strengthen information transparency and accountability, to ensure that businesses voluntarily disclose nature-related financial risks and incorporate environmental, social and governance (ESG) factors into their risk management and investment decision-making.

3. **Leverage Fourth Industrial Revolution technologies and innovation:**
   Chinese businesses are well-positioned to leverage their leading edge in innovative technologies and manufacturing capacity to accelerate the nature-positive transition. For example, new technologies, such as the internet of things, big data, drones and robots, can improve agricultural production efficiency; 5G network data centres and blockchain can support the upgrading of traditional infrastructure; 3D printing and information modelling can help reduce construction waste; and government and public data can be used to govern cities more efficiently.

4. **Mobilize public funds and private investment:**
   Investment of $535 billion per year through to 2030 will be required to seize all opportunities across the three socio-economic systems. Although this seems a huge sum, it is only a proportion of the $884 billion of green credits amassed by six state-owned banks by the end of 2020.

We are fast approaching irreversible tipping points in climate and natural ecosystems. China's best chance to achieve this transition is through building consensus around the need to strengthen policy and supervision, introduce more investment and financial support, and use technology and innovation levers to usher in a carbon-neutral, nature-positive future.

1 Nature loss and the transition of three socio-economic systems facing China

Victoria bay and Victoria peak in Hong Kong

GETTY/CHINAFACE

1.1 China's natural ecosystems are under stress

Since the reforms and opening-up of the economy in the late 1970s, China has achieved remarkable economic success, with GDP growing at an average annual rate of nearly 10% from 1978 to 2011.[3] In 2010, China became the world's second-largest economy. The country has markedly improved its citizens' lives and has succeeded in building a moderately prosperous society. The past four decades have seen 700 million people lifted out of poverty, with the urbanization rate climbing from 18% in 1978 to 63.9% in 2020. Average annual income per capita increased from $120 in 1978 to $9,000 in 2019.[4]

The country also features rich biodiversity and harbours is home to nearly 10% of all plant species and 14% of all animals on earth, including 3,000 endangered species.[5] However, fast economic growth and rising urbanization have come at a heavy cost to China's natural ecosystems. The mangrove area has declined by 40% since the 1950s, moderately or severely degraded grasslands account for more than one-third of the total[6] and 21% of all vertebrates are threatened.[7] According to the *National Survey and Assessment on Decadal Changes in Ecosystems of China*[8], from 2000 to 2010, the area of China's urban areas, forests and wetlands has increased, while the area of agricultural land, shrublands, grasslands and deserts has decreased. The quality of forest, shrublands and grassland remains low, with less than a quarter of these three ecosystems are rated "excellent" or "good" quality. China's ecosystem service functions are vulnerable and cannot meet the requirements to support sustainable economic and social development.

China's ecological and environmental problems remain serious. The challenges caused by urbanization and industrialization have intensified. Soil erosion, land and rock desertification, and reduction of natural habitats are major concerns. Watersheds and coastal zones are deteriorating, along with living conditions in urban areas. Mineral resource extraction continues to inflict considerable damage to ecosystems. China is facing grave ecological security challenges from its rapidly increasing footprint on nature and the environment. The country faces a conspicuous contradiction between ecological protection and economic development.

There are five direct drivers of biodiversity loss (see Figure 1), of which those with the largest global impacts have been (in descending order): changes in land and sea use, direct exploitation of organisms, climate change, pollution, and invasion of alien species.[9]

GETTY/CHINAPHOTOGRAPHER

FIGURE 1: **Drivers of biodiversity loss and impacts on nature in China**

1. Changes in land and sea use

- Agriculture and urban expansion are the most common forms of land-use change. By 2016, China's towns and cities covered 94,000 km^2, accounting for 1% of national land area, with an average annual growth rate of 3.8%. In 2017, farmland accounted for 14% of national land area but was severely degraded – only 31% of China's arable land was highly productive.
- Due to the impact of wetland reclamation and beach polder, the area of wetlands has decreased by 9% compared to a decade ago. Changes in ocean use mainly include the development of coastal infrastructure and aquaculture.

2. Overexploitation of organisms

- Hundreds of species of wild animals and plants are poached and illegally gathered in China. Overfishing and illegal fishing have made around 90 common or dominant fish species in the Pearl River rare or endangered.

3. Climate change

- The 2010-2019 average sea levels along the Chinese coast were the highest in 40 years, one meter higher than the 1980 -1989 average, which has led to ecological damage, increased risk of soil salinization and coastal zone disasters and flooding.
- The frequency and intensity of extreme weather events, including fires, floods and droughts, have increased over the past 50 years.

4. Pollution

- Multiple types of pollution lead to air, water and soil contamination, including marine plastics, untreated urban and rural waste, pollutants from industrial, mining and agricultural activities, oil spills and toxic waste dumping.
- As a result of environmental pollution, 16 out of China's 24 ecological monitoring areas in typical marine ecosystems – such as estuaries, bays, mudflat wetlands, coral reefs, mangroves and seagrass beds – are in a sub-healthy state while one is unhealthy.

5. Invasive alien species

- In 2020, more than 660 invasive alien species were found in China, of which 71 species have caused or could cause threats to natural ecosystems and are recorded in the List of Invasive Alien Species in China. For example, the main invasive pest of field crops, the sooty fly, can spread more than 70 viruses and has reached most areas of China, affecting hundreds of thousands or even millions of hectares of crops each year.

Source: Former Ministry of Land and Resources, National Urban Land Use Data Summary Report (2017); Ministry of Agriculture and Rural Affairs, National Communiqué on the Quality Rating of Land in 2020; National Forestry and Grassland Administration, Main Results of the Second National Wetland Resources Survey (2009-2013); Ministry of Ecology and Environment, Ministry of Agriculture and Rural Affairs, Ministry of Water Resources, Aquatic Biodiversity Conservation Program for Key Watersheds; Ministry of Ecology and Environment, China's Ecological Environment Status Bulletin 2020; Ministry of Ecology and Environment, China's Marine Ecological Environment Status Bulletin 2020.

1.2 Nature loss creates significant risks for China's economy

Direct risks to the economy from the dependence of business on nature

Nearly two-thirds of China's GDP is at risk due to biodiversity and nature loss

Nature sustains human production and life in many ways, such as providing nutritious diets and clean water, controlling diseases, regulating climate, supporting crop pollination and soil formation, and enhancing entertainment, cultural and spiritual value. Human business activities inevitably have an impact on nature and almost all businesses, through their operations and supply chains, depend directly or indirectly on the natural ecosystem and its services.

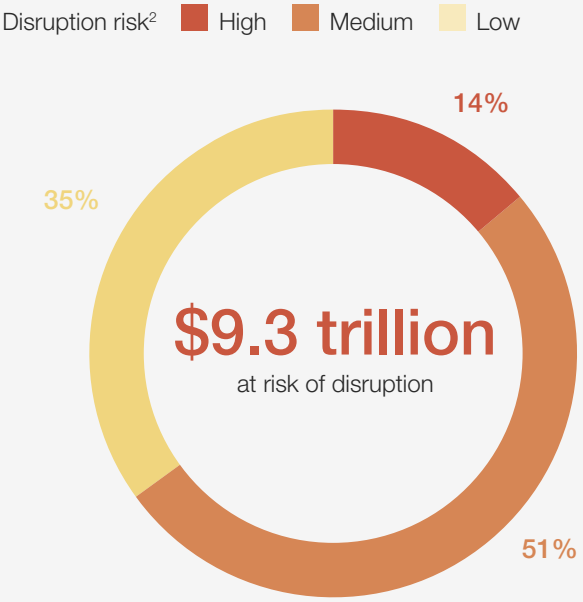
The World Economic Forum's *New Nature Economy Report II: The Future of Nature and Business*[10] has identified three socio-economic systems inextricably associated with biodiversity threats:

- Food, land and ocean use
- Infrastructure and the built environment
- Energy and extractives

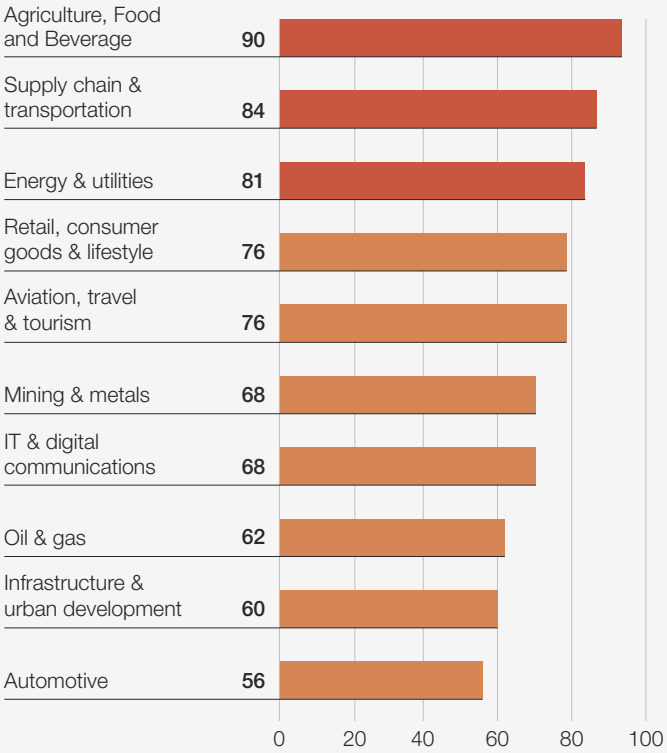
These three socio-economic systems are not only key contributors to biodiversity and nature loss, they are also at severe risk from such losses. Using the analytical framework presented by *The Future of Nature and Business*, this report finds that an estimated $9 trillion of China's annual economic output is at risk due to the dependence of business on nature and its services, representing 65% of total GDP. In other words, nearly two-thirds of China's GDP is at risk due to biodiversity and nature loss. This is higher than the equivalent figures at the global level (just over half of global GDP at risk) and the overall Asian level (63% at risk). Agriculture, food and beverages, supply chains and transportation, and energy and utilities are the sectors at greatest risk from nature loss."

FIGURE 2: **Economic value and industry sectors at risk from nature loss**

% GDP[1] at risk of disruption by biodiversity and nature loss



Top 10 industry sectors at risk of disruption (max=100)



1. GDP in China reported to be $14.3 trillion (2019)
2. Disruption risk is calculated for 19 industry sectors as classified by the World Economic Forum and based on their estimated contributions to GDP. Sectors are assigned disruption risk scores out of 100, based on the average number of business operations disrupted by 27 drivers of environmental change and their impacts on natural capital assets (through 21 ecosystem services). A sector with over 80% of its production processes materially disrupted is considered "high" risk; a sector with 55%-80% of production processes disrupted is "medium" risk; and a sector with less than 55% of production processes disrupted is "low" risk.

Source: World Bank; Natural Capital Finance Alliance; ENCORE database; WEF; AlphaBeta analysis

Nature loss creates regulatory and compliance risks

In recent years, China has promoted biodiversity management through policies and measures such as improving biodiversity protection mechanisms and strengthening law enforcement, inspection and accountability. During the 13th Five-Year Plan period (2016-2020), China stepped up efforts to supervise eco-environmental law enforcement, handling 833,000 environmental administrative penalty cases, with fines totalling nearly $8 billion.[11] The Chinese government's intensified action against nature loss will expose businesses to greater regulatory risk.

Meanwhile, producers and end-consumers are setting higher standards for food safety, labour conditions, plant quarantine and environmental protection, which may be accelerated in the context of COVID-19. Worldwide scrutiny of the legality of goods, such as forest products, soybeans and palm oil, is rapidly increasing. With respect to timber, for instance, many of the world's major importing nations have recently established laws banning the import of illegally harvested or traded wood products. These nations account for 52% of the world's forest product imports.[12] For example, the European Union (EU), China's second-largest trading partner, recently announced a draft law to curb deforestation, aiming to ban imports of food such as beef and coffee from areas facing the risk of deforestation.[13]

Transition pressure from consumers and investors

As the concepts of ecological civilization and sustainable development prevail, more Chinese consumers are rethinking the impact of consumer behaviour on the environment and shifting towards environmentally friendly materials, buying non-deforestation food, eating organic supplies and preferring sustainability-certified products. Animal-fur products, for example, are declining in popularity.

Ratings agencies have started to include nature-related disclosures in their assessments, while institutional investors are demanding more accountability in terms of the environmental risks of business operations. Environmental, social and governance (ESG) factors are becoming an important basis for investors to assess corporate value. On 18 December 2019, The Stock Exchange of Hong Kong Limited (HKEX) issued a new *ESG Reporting Guide* to regulate the requirements for issuers' information and disclosure of ESG activities. Additionally, the growing demand of investors for sustainable assets enables a financing channel for businesses through the issuing of green bonds. This means companies will incur higher costs of capital when engaging in nature-degrading practices.

GETTY/Kilito Chan

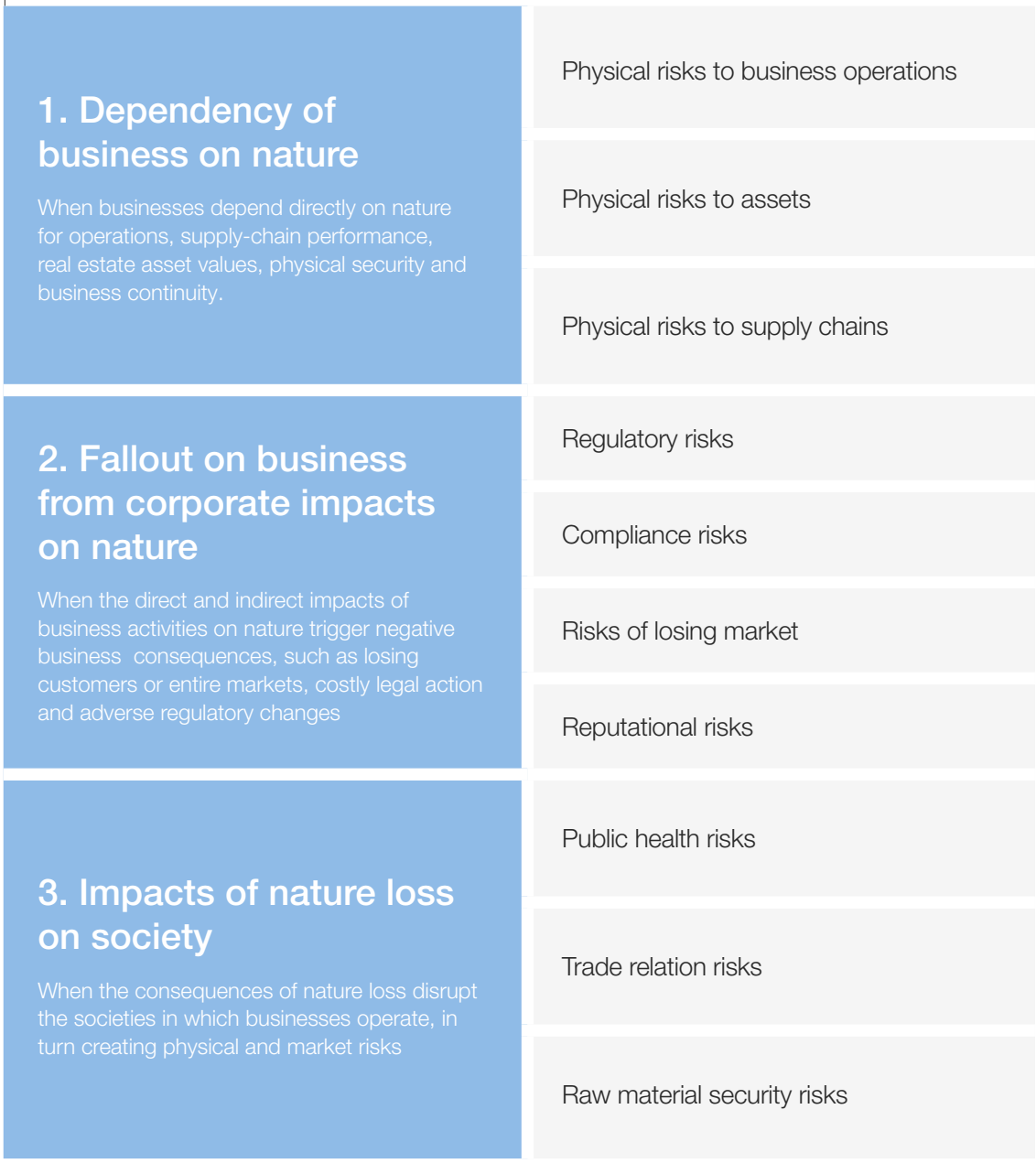
Nature loss is linked to public health, trade relations, resource safety and other social problems

Besides nature's contribution to economic activities, clean air, freshwater and fertile soils (to name a few ecosystem services) provide vital public goods on which human societies rely for their survival and functioning. For instance, healthy ecosystems are closely linked to public health. Outdoor air pollution is responsible for the deaths of an estimated 4.2 million people each year globally, according to the World Health Organization,[14] while more suffer from asthma and heart disease.[15]

The destruction of natural habitats caused by human activities leads to ecological imbalance, with some viruses present in wild animals spreading directly to human beings.[16] Emerging infectious disease (EID) events are dominated by zoonoses (60% of EIDs), of which over 70% originate in wildlife, such as Ebola virus and SARS-CoV-2 (the virus causing COVID-19).[17]

Large-scale loss of nature also has the potential to affect trade relations between countries. The fierce competition for natural resources between major producers and consumers leaves countries heavily dependent on such resources at the mercy of fluctuations in international supply and demand. For example, China depends on imports of non-renewable natural resources, such as oil and iron ore, and these resources often come from a limited range of suppliers.[18]

FIGURE 3: **Three ways in which the destruction of biodiversity and ecosystems creates risks for businesses**



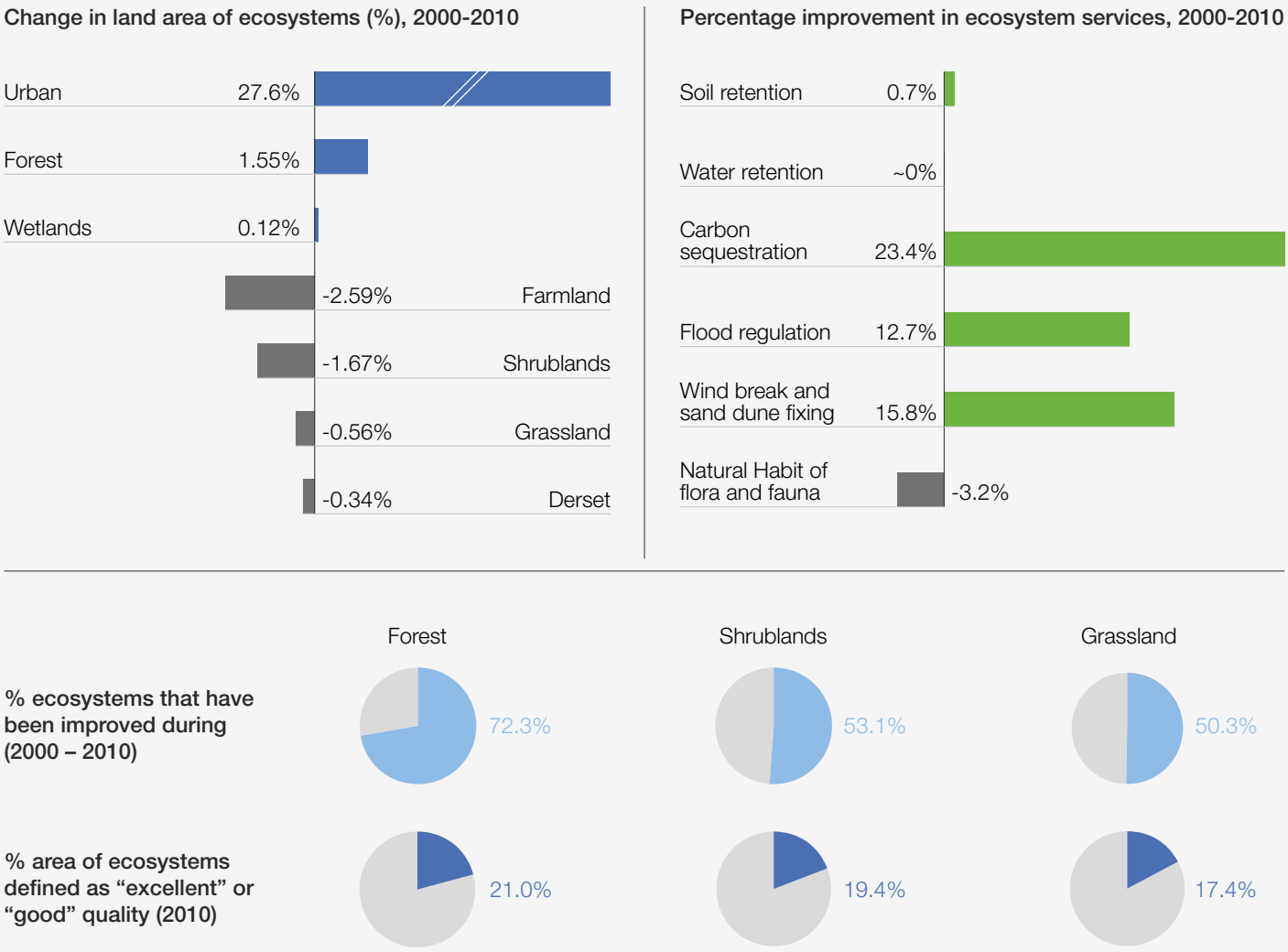
1.3 China's actions against nature loss and climate change

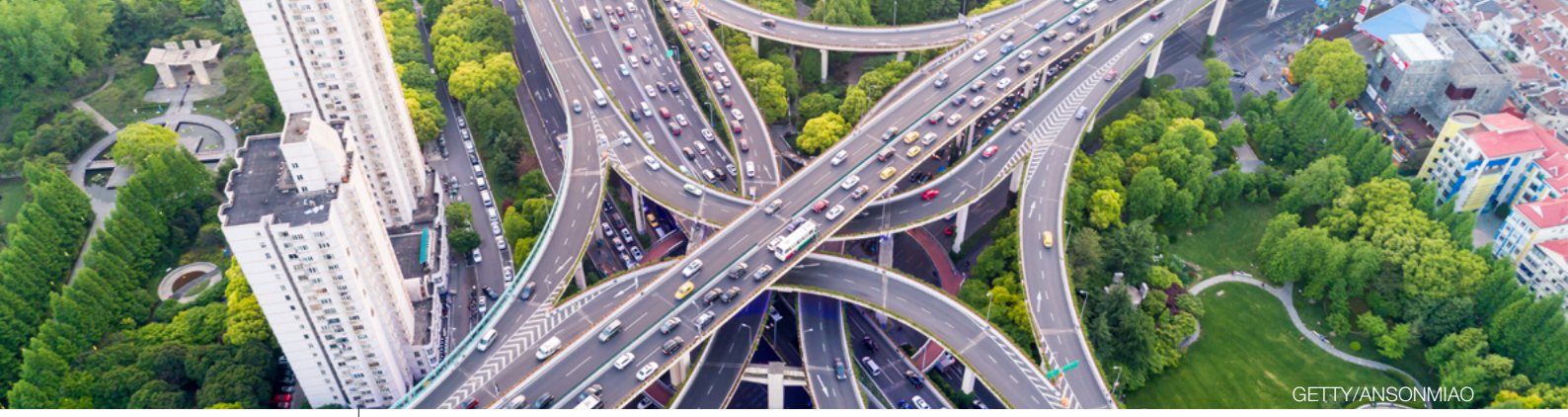
China is in a unique position to lead the transition towards a new nature-positive, net-zero economy. The country has issued and implemented many important policies for nature restoration and protection, and enshrined the concept of ecological civilization in its constitution.

These policies and actions have shown results. According to the National Survey and Assessment on Decadal Changes in Ecosystems of China, from 2000 to 2010, the area of urban, forest and wetland ecosystems increased by 27.6%, 1.55% and 0.12% respectively. However, the area of farmland, scrub, grassland and desert ecosystems decreased. The same decade saw an improvement in the quality of 72.3% of forests, 53.1% of scrub and 50.3% of grassland ecosystems in China. The ecological problems caused by agricultural production showed signs of improvement, as did ecosystem services such as soil retention, carbon sequestration, flood regulation, wind breaks and preventing the spread of sand dunes. Water retention did not change significantly from 2000-2010, while the habitat area of wild animals and plants decreased by 3.2% over the period (see Figure 4).

The government is updating the *China National Biodiversity Conservation Strategy and Action Plan (2011-2030)* to build a system of protected areas (PA) with a focus on national parks. Currently, China has established over 10,000 PAs of all types, including national parks and other categories of protected areas, accounting for about 18% of its total land area.[19] In 2017, China created the concept of an "ecological conservation red line", which proposed delineating and strictly observing the protection of key ecological functions and environmentally sensitive areas within those red lines. The initially delineated

FIGURE 4: **Key findings of the National Survey and Assessment on Decadal Changes in Ecosystems of China (2000-2010)**





Aerial view of Shanghai Skyline

national ecological conservation red line area currently encompasses at least 25% of the country's land area.[20]

China has adopted a holistic approach to conserving its mountains, rivers, forests, farmlands, lakes, grasslands and deserts. It is building a national spatial planning system that integrates multiple regulations.[21] It has launched an action plan to establish a market-orientated and diversified ecological conservation compensation mechanism[22] and a national initiative to establish an ecological product value-realization mechanism.[23] As a result of a range of ecological conservation and restoration works, the area and stock of forests in China have maintained double-digit growth for over 30 consecutive years.[24] China accounted for 25% of the global net increase in green area between 2000 and 2017, with its contribution ratio ranking first in the world.[25]

In 2020, the government released the *Master Plan for National Key Ecosystem Protection and Restoration Major Projects (2021-2035)*, specifying conservation programmes for three eco-zones and four eco-belts.[26] The masterplan's goals for 2035 include the following:

- Expand forest coverage to 26% of China's terrestrial area, increase its growing stock volume to 21 billion cubic metres, and maintain the area of natural forest at 200 million hectares
- Cover 60% of grassland with vegetation
- Ensure no further loss of wetlands and protect 60% of wetlands
- Increase the total integrated management area for soil and water erosion control to 56.4 million hectares
- Ensure 75% of recoverable desertified area is under treatment
- Safeguard at least 35% of the country's natural coastlines and prevent the marine ecological condition from worsening
- Ensure the National Park-centred protected areas system accounts for over 18% of national terrestrial areas
- Fully protect endangered species and their habitats

Chinese companies have embarked on the net-zero and nature-positive transition in parallel with government policies. In response to guidelines released in February 2021 by China's State Council on building an economic system featuring green, low-carbon and circular development, a number of Chinese businesses have taken action. From traditional high-CO_2 emitters such as energy and steel, to financial institutions and emerging tech industries, businesses are scrambling to frame their carbon-neutrality goals. Some have not only been engaged in government-led activities, but have also made voluntary commitments to targets for environmental protection, the circular economy and biodiversity conservation.

In June 2021, the Secretariat of the Convention on Biological Diversity and China's Ministry of Ecology and Environment (MEE) co-hosted an event entitled The Business and Finance Journey to Kunming: We are Part of the Solution." The event formed part of the Business and Biodiversity Forum, a parallel event of the 15th Conference of the Parties (COP15) of the Convention on Biological Diversity, held in Kunming, Yunnan Province. In 2021, MEE launched the Plan of the China Business and Biodiversity Partnership.[27] Chinese businesses are also leaders in multiple Fourth Industrial Revolution technologies such as drones, 5G, the internet of things and 3D printing. They endow China, the world's second largest economy, with strong capabilities to drive the transition of the three socio-economic systems outlined in Table 1.

China has partaken extensively in international exchanges and cooperation related to biodiversity and climate change. As the host of the UN Convention on Biodiversity's (CBD) COP15, China successfully organized the first phase of the Biodiversity Conference in October 2021 with the adoption of the *Kunming Declaration*, in which more than 100 countries committed to live in harmony with nature. Furthermore, in 2019, China launched the Belt and Road Initiative International Green Development Coalition (BRIGC). At the Glasgow COP26 Climate Change Conference in November 2021, 141 states including China signed a declaration committing to halt and reverse deforestation by 2030.

1.4 Climate change and biodiversity loss are two sides of the same coin

According to the *Global Assessment Report on Biodiversity and Ecosystem Services*, released by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES),[28] climate change is the main driver responsible for between 11% and 16% of biodiversity loss. At the same time, agriculture, forestry and other land-use change are responsible for 23% of GHG emissions globally,[29] while agricultural expansion is the main driver for habitat loss.

Fighting climate change is critical, but if the other direct drivers of nature loss are not tackled concurrently – such as controlling the expansion of land and ocean use, curbing the excessive use of biological resources, reducing pollution and tackling invasive species – we will not be able to halt biodiversity loss and protect and restore nature. Businesses, through their operations and supply chains, can have long-lasting harmful consequences for nature, which in turn trigger direct operational risks as well as indirect regulatory, market and reputational risks.

At the same time, nature may be China's strongest ally in fighting climate change. Nature-based solutions could provide 37% of the cost-effective CO_2 mitigation needed up to 2030 to have a chance to limit warming below 2°C.[30] Farmland soils, for instance, have enormous potential for carbon sequestration and emissions reduction. The first metre of soil across the globe holds almost double the amount of carbon in our atmosphere.[31] According to research from China's National Academy of Sciences, the carbon storage potential of China's terrestrial ecosystem (comprising forest, shrubland, grassland and cropland) totals 80 billion tonnes,[32] around eight times the country's total carbon emissions in 2019.[33] Of this total capacity, 83% comes from the soil carbon pool.

Climate change, biodiversity loss and social inequality are closely linked. We cannot address one while neglecting the others. COVID-19 dealt a heavy blow to the global economy, but economic recovery from the pandemic must pursue a green and low-carbon pathway to address the deeper and wider global priorities of a stable climate and resilient biodiversity. In parallel with its ambitious targets to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060, China is updating its biodiversity conservation strategy, targets and action plan. There is huge potential of synergy to be realized if green and low-carbon circular development is integrated with climate and biodiversity goals, turning nature capital into the engine for green economic growth, and securing the transition towards a carbon-neutral, nature-positive future.

“ Nature-based solutions could provide 37% of the cost-effective CO_2 mitigation needed up to 2030 to have a chance to limit warming below 2°C

Green roof with rooftop gardens and solar panels

ARTUR DEBAT/GETTY

1.5 Transitions in three socio-economic systems to deliver a nature-positive economy

China is on track to sustain steady, high-quality economic growth in the coming decades. Yet due to its large population, the pressures of economic and social development on natural resources and the environment are unlikely to abate. China's middle class, currently more than 400 million people, is projected to reach 600 million by 2030, representing over 40% of the total population.[34] If the rate of urbanization continues to increase by 1% a year, the proportion of the population living in urban areas will exceed 70% by 2035.[35] China accounts for over 20% of the world's total energy consumption[36] and this is set to increase. However, its renewables sector is strong: China is projected to remain the single largest hydropower market through to 2030,[37] while its total installed solar and wind capacity may double to exceed 1.2 billion kilowatts over the same period.[38]

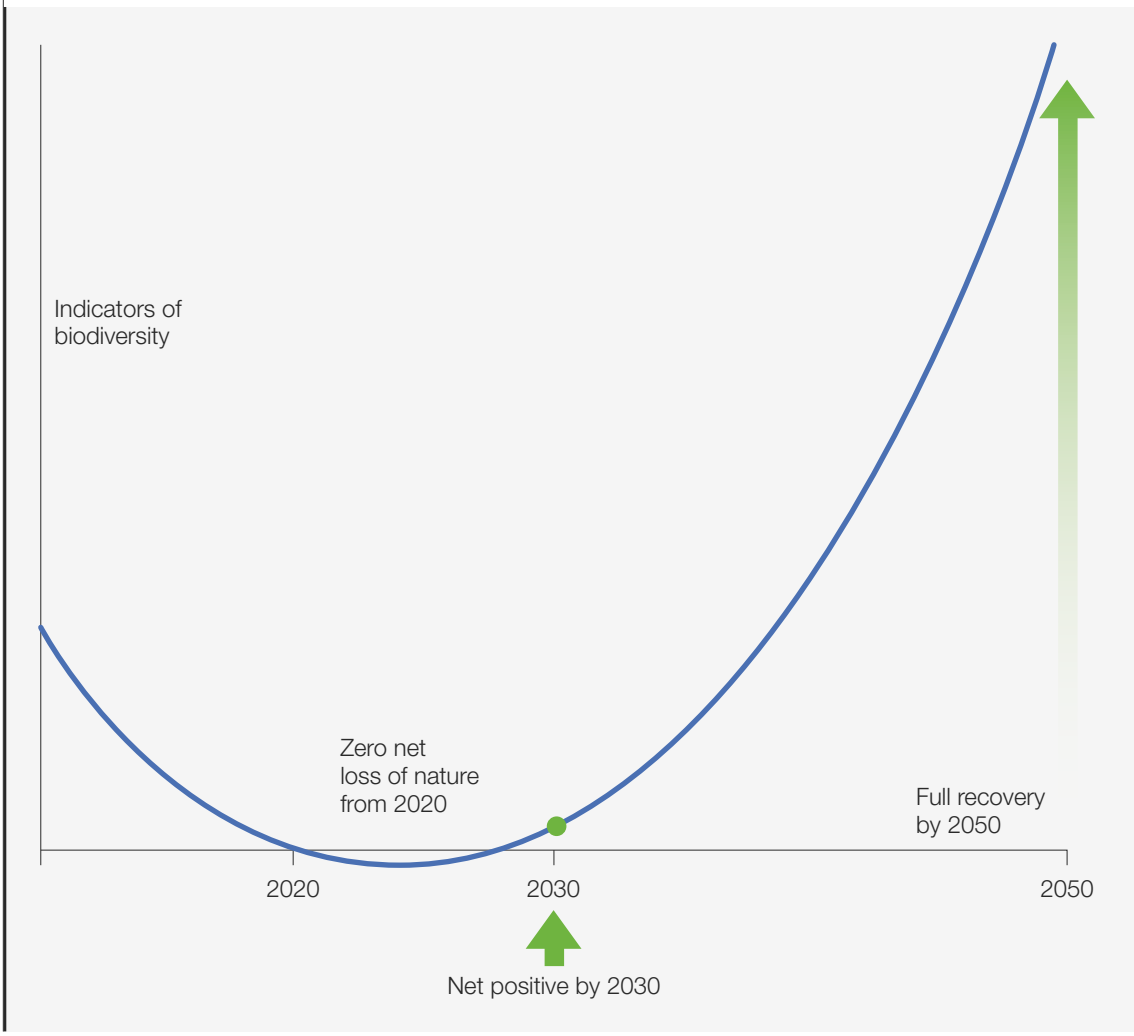
As the middle class grows and changes in consumer behaviour and urbanization continue, pursuing the old unsustainable economic model of "high input, high energy consumption, high pollution, low output" will place enormous strains on China's natural ecosystems, driving them to the brink of irreversible tipping points. China's economic development, social stability and the well-being of its people are all highly dependent on natural ecosystems and their services. The current economic development model must be transformed to reverse the loss of the country's biodiversity and to set it on a path towards full recovery by 2050.

Nature-positive development is a trajectory, from a 2020 baseline, to bend the curve of biodiversity loss from negative to positive.

The goal has three measurable objectives:

1. Zero net loss of nature from 2020
2. Net positive by 2030
3. Full recovery by 2050, to achieve the CBD's 2050 vision of "Living in Harmony with Nature"

FIGURE 5: **The trajectory of nature positive by 2030[39]**



Fifteen transitions in the following three key socio-economic systems (see Figure 6) can deliver this nature-positive vision:

- Food, land and ocean use
- Infrastructure and the built environment
- Energy and extractives

These systems are not only the main drivers of the current nature crisis, they also stand to lose the most from it and are crucial for China's economic development and business prosperity. Consequently, these three socio-economic systems are vital for fostering a nature-positive economy and securing the transition towards an economic pattern of living in harmony with nature.

FIGURE 6: **Fifteen transitions in three socio-economic systems to secure a nature-positive economy**

Food, land- and ocean-use system

1. Ecosystem restoration and avoided land-use and ocean-use expansion
2. Productive and regenerative agriculture
3. Healthy and productive oceans
4. Sustainable forest management
5. Planet-compatible consumption
6. Transparent and sustainable supply chains

Infrastructure and built-environment system

1. Compact built environment
2. Nature-positive built-environment design
3. Planet-compatible urban utilities
4. Nature as infrastructure
5. Nature-positive connecting infrastructure

Energy and extractives system

1. Circular and resource-efficient models for materials
2. Nature-positive metals and minerals extraction
3. Sustainable materials supply chains
4. Nature-positive energy transition

15 nature-positive transitions could add $1.9 trillion in business value to China's economy and create 88 million new jobs by 2030

The 15 priority transitions across three socio-economic systems presented in Figure 6 constitute a basic framework for concerted action to deliver a nature-positive economic development pathway. As key stakeholders, businesses should, with their technology, innovation and resources, make the necessary shifts towards increasing their investment in nature protection and restoration and nature-based solutions. By doing so, China can stave off the rising risks associated with the loss of nature while also meeting the growing demands of investors, consumers and regulators for businesses.

At the same time, a nature-positive development model can unlock significant benefits. These transitions are projected to add $1.9 trillion in annual business value and could create 88 million jobs in China by 2030. Furthermore, these jobs are likely to be more sustainable and resilient than those in business-as-usual models.

2 Nature-positive food, land- and ocean-use system in China

Farmer working in a rice field farmland

GETTY/CHADCHAI RA-NGUBPAI

In China, 20 of the 97 industries listed under national economic categories fall within the food, land- and ocean-use system (see Figure 7). Such industries rely on either the direct extraction of resources from land, forests and oceans or the provision of ecosystem services, such as healthy soils, crop pollination, freshwater supply, climate regulation and nutrient circulation.

Desertification now afflicts 27% of China's land territory.[40] Arable land is seriously degraded, with high-yielding cropland representing just 31% of the total arable land area.[41] Agricultural expansion is the main driver for habitat loss and a major threat to biodiversity.[42] The world's food systems are responsible for more than one-third of global anthropogenic greenhouse gas emissions, according to a study released in 2021 by FAO.[43]

China contributed 22% to global consumption growth in agricultural products between 2001 and 2018.[44] As China's population increases, the growing demand of middle- and high-class consumers for food and clothing, rising urbanization rates and the expansion of agricultural land are all exerting mounting pressure on this system.

2.1 Six priority transitions – a summary

Six priority transitions can set China's food, land- and ocean-use system on a pathway towards nature-positive development. The transitions are summarized in this section below and each is addressed in greater detail in subsequent sections of this chapter.

1. Ecosystem restoration and avoided land-use and ocean-use expansion
2. Productive and regenerative agriculture
3. Healthy and productive oceans
4. Sustainable management of forests
5. Planet-compatible consumption
6. Transparent and sustainable supply chains

1. Ecosystem restoration and avoided land-use and ocean-use expansion

The restoration and maintenance of natural ecosystem integrity should be accelerated, along with control over the use of important ecosystems such as forests, grassland, wetlands, freshwater and oceans. China has chalked up some achievements in delineating ecological conservation red lines, coordinating the integrated protection and restoration of mountains, rivers, forests, fields, lakes and grasses, among others.

Business action needs to play a greater role – for example, through no-deforestation policies in commodity supply chains or choosing nature-based solutions to achieve emissions-reduction targets.

2. Productive and regenerative agriculture

Regenerative agriculture with stable and high yields should be developed. China faces broader challenges in agricultural production, including the irrational use of fertilizers and pesticides, which lead to arable land degradation. China's 2017 *Bulletin on the Second National Census on Pollution Sources* – a once-in-a-decade survey – revealed a large amount of water pollutants being discharged from agricultural sources, contributing to half the country's entire water pollutants.[45] This not only reduces grain production and income, but the groundwater pollution partially caused by it also threatens the physical health of rural residents.

The government needs to further promote agricultural reform, strengthen training and capacity building for smallholder farmers, encourage large farms to develop precision agriculture, advance agricultural biotech R&D, and align agricultural production with the bearing capacity of natural resources and the environment by 2035.

FIGURE 7: **Six transitions and 20 industries in the food, land- and ocean-use system**

Sector role in transition ■ Principal ■ Enabling

Sectors	Transitions: Ecosystem restoration and avoided land-use and ocean-use expansion	Productive and regenerative agriculture	Healthy and productive oceans	Sustainable forest management	Planet-compatible consumption	Transparent and sustainable supply chains
Agriculture	Principal	Principal	Enabling	Enabling	Principal	Principal
Forestry	Principal	Enabling	Enabling	Principal	Principal	Principal
Livestock	Principal	Principal	Enabling	Enabling	Principal	Principal
Fisheries	Principal	Principal	Principal	Enabling	Principal	Principal
Auxiliary activities for agriculture, forestry, animal husbandry and fishery	Enabling	Principal	Principal	Principal	Enabling	Enabling
Agricultural and sideline food-processing	Enabling	Enabling	Enabling	Enabling	Principal	Principal
Food manufacturing	Enabling	Enabling	Enabling	Enabling	Principal	Principal
Wine, beverage and refined tea manufacturing	Enabling	Enabling	Enabling	Enabling	Principal	Principal
Tobacco	Principal	Principal	Enabling	Enabling	Enabling	Enabling
Textiles	Enabling	Principal	Enabling	Enabling	Principal	Principal
Apparel	Enabling	Principal	Enabling	Enabling	Principal	Principal
Leather, fur and feather products and footwear	Enabling	Principal	Enabling	Enabling	Principal	Principal
Wood processing and wood, bamboo, rattan, palm and grass products	Enabling	Enabling	Enabling	Principal	Principal	Principal
Furniture manufacturing	Enabling	Enabling	Enabling	Enabling	Principal	Principal
Paper and paper products	Enabling	Enabling	Enabling	Enabling	Principal	Principal
Printing and recording media copying	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling
Hospitality	Enabling	Enabling	Enabling	Enabling	Principal	Enabling
Catering	Enabling	Principal	Enabling	Enabling	Principal	Principal
Wholesale	Enabling	Principal	Enabling	Enabling	Principal	Principal
Retail	Enabling	Principal	Enabling	Enabling	Principal	Principal

Sources: Industrial classification for national economic activities (GB/T 4754—2017), World Economic Forum, GoldenBee analysis.

3. Healthy and productive oceans

Existing marine environmental pollution should be treated, and the sustainable management of marine resources should be pursued to create healthy and productive oceans. China has been the largest producer of aquatic products for 30 years, accounting for around 35% of the world's total.[46] Since 1994, China's offshore fishing has gone 50% over its annual allowable catch, which coupled with a surge in distant water fishing, is putting a heavy strain on the marine environment.

China must advance the protection and sustainable utilization of marine fisheries, through practising stricter fishing moratoriums, cracking down on illegal offshore fishing and pursuing sustainable aquaculture on a broader scale.

4. Sustainable forest management

The sustainable management of forests should be strengthened to secure ecological functions such as cleaning water, maintaining soil, purifying air, sustaining biodiversity, equestering carbon, providing oxygen and regulating the climate, while addressing the demands of society and the economy, such as providing community benefits and income for forestry practitioners. Though China has increased its forest cover from 8.6% of total land area in 1949 to 23% in 2020,[47] the quality of forests and their management need to be improved, with less than 3% of all China's forests gaining domestic or international sustainable forest management certifications, such as those provided by the Forest Stewardship Council (FSC), the China Forest Certification Council (CFCC) or the Programme for the Endorsement of Forest Certification Schemes (PEFC).

China should further pursue forest protection, restoration and sustainable use, and develop carbon sink forests, commercial forests, economic forests and a non-timber forest-based economy, among other initiatives.

5. Planet-compatible consumption

Overconsumption of resource-intensive foods and food waste should be minimized or eliminated through practising nature-compatible consumption. Due to its large population base, China will need to sustain a growing demand for food and natural fibre as living standards improve and eating habits change. However, China's urban catering industry alone generates 17-18 million tonnes of food waste every year – enough to feed 30-50 million people.[48]

China needs to ensure the certification of agricultural goods, such as requiring product tags that include the carbon footprint of food items and promoting an understanding of healthy diets – on both supply and demand sides. This will diversify the Chinese diet structure, by increasing the ratio of foods that substitute meat and dairy products while consuming fewer resources, such as vegetables, nuts and seeds.

6. Transparent and sustainable supply chains

The transformation of farming, forestry, livestock and fishing systems requires transparent and sustainable supply chains. Direct supply modes such as contract farming and supply from farmers to stores should be developed to reduce food loss in supply chains. Digital information technology can be leveraged to establish a transparent traceability system for agricultural products to ensure food safety with traceable information.

The government should embrace measures including zero-deforestation, low-carbon, sustainable operations and supply chain certification in sectors such as palm oil, soybeans, beef and forest products. These measures need to be aligned with international standards to avoid the risk of nature loss through both upstream and downstream commodity supply chains.

2.2 Ecosystem restoration and avoided land-use and ocean-use expansion

What is it?

As human activities exert unprecedented strains on land and ocean resources, the ever-expanding footprints of agriculture, forestry, animal husbandry and fisheries are unsustainable. The habitable area of the earth is 71% of the total land area, and agriculture occupies 49% of it.[49] It also uses 70% of all water withdrawn from aquifers, streams and lakes.[50] The agriculture sector must be rapidly transformed to avoid land and ocean over-exploitation. The conservation and restoration of land, especially of forests and mangroves, could deliver a significant portion of the mitigation needed to control global warming. Additionally, it brings a range of incalculable benefits that include promoting biodiversity, greater resilience of human settlements to extreme weather events, and improved water security.

To achieve this transition, the first step is to restore degraded landscapes, protect ecological areas of significant value for their biodiversity and ecosystem services, conserve sensitive and fragile ecosystems, and avoid the occupation of more ecological areas for development. It is necessary to reduce the footprints of agriculture, forestry, animal husbandry and fisheries on ecosystems. The government can also engage in initiatives such as ecotourism to enhance the economic, social and environmental benefits of preserving nature.

CASE STUDY

Saihanba Mechanical Forest Farm restores bare land through large-scale afforestation

Saihanba is today a 700 square-kilometre national forest park in Hebei province. It used to feature lush forests, abundant wetlands and grasslands. However, the government allowed land reclamation and deforestation during the late Qing Dynasty so that, coupled with the effect of years of war, Saihanba had deteriorated by the early 1950s into a plateau desert with little forest and grass vegetation. Situated just over 400 kilometres from Beijing, Saihanba Mechanical Forest Farm together with the surrounding Hunshandake Desert become the primary source of dust storms for Beijing and Tianjin.

China principally carries out its afforestation, forest management and ecological restoration through state-owned forest farms. Currently, there are at least 4,297 state-owned forest farms, with 800,000 km^2 under operation in total, around 8% of China's total land area.[51] State-owned forest farms are one of the main sources of afforestation in China and they play an important role in the restoration of forest ecosystems. Saihanba Mechanical Forest Farm was established in 1962 by the former Ministry of Forestry as a state-owned forest farm.

Saihanba Mechanical Forest Farm has overcome various technical difficulties to raise seedlings in an alpine region and carry out large-scale afforestation. Since the 1980s, scientific techniques such as thinning, targeted cutting, block clear-cutting and planting deciduous forests among coniferous forests have been adopted to optimize the structure and quality of Saihanba's forests. An effective fire monitoring and prevention system has been built and no fire incidents have occurred since the forest farm was established.

After a series of challenges over three generations, Saihanba Mechanical Forest Farm has created a green ecological barrier of 93,000 hectares for the cities of Beijing, Tianjin and Hebei. The forest area has increased by 3.8-fold, the forest stock has multiplied by 30 times, forest coverage has soared from 11% to 82%, the average count of windy days has decreased from 83 to 53 days a year, and average annual precipitation has risen from 410 mm to 479 mm.

Each year, the forest farm conserves and purifies 284 million cubic metres of water, fixes 860,300 tonnes of carbon dioxide and releases 598,400 tonnes of oxygen. Additionally, its green industries such as ecotourism, seedling for landscaping and carbon sequestration relying on its vast forest resources have secured ecological restoration and driven local economic development. Since its establishment, the forest farm has created $23.5 million of income in labour services for local workers. Each year, it contributes over $9 million in income to local communities and helps over 10,000 people to escape poverty.

Sources:

1. "Typical Cases of Ecological Restoration in China (1) - Saihanba Mechanical Forest Farm Builds a Green Ecological Barrier by Sand and Desert Control", 16 October 2021, https://m.thepaper.cn/baijiahao_14936318.

2. "China's carbon neutral goal: Xi Jinping visits historic tree farm to highlight green targets", South China Morning Post, 24 August 2021, https://www.scmp.com/news/china/politics/article/3146210/chinas-carbon-neutral-goal-xi-jinping-visits-historic-tree-farm.

CASE STUDY

Organic dairy industry in the desert curbs expansion of land use

China is one of the countries most severely impacted by desertification in the world. It affects more than 50 million people, nearly 4 million hectares of farmland and 5 million hectares of grassland.[52]

In 2009, Inner Mongolia China Shengmu Organic Milk Limited selected Ulan Buh Desert as its organic dairy production base, largely because the area is free from industrial and chemical agricultural pollution. Since then, Shengmu has invested more than $1.1 billion in large-scale ecological management.

Shengmu combats desertification by a combination of xeromorphic arbours (drought-adapted trees), sandy shrubs, perennial and annual forage. Currently, 97 million trees of various kinds have been planted in Ulan Buh Desert, and more than 200 square-kilometres of desert have been afforested. Afforestation now affords three levels of protection, reducing local wind speeds from 40-60 km/h to 20-40 km/h.

At the same time, a combination of afforestation and animal husbandry enables organic recycling. Organic fertilizer produced by cow dung from desert oasis pasture has improved soil fertility and water and fertilizer holding capacity. The pasture produces hundreds of thousands of tonnes of high-quality organic fertilizer every year, with a total volume of 600,000 m^3, which could cover nearly 10,000 hectares of land if spread on the desert.

According to the natural capital accounting method, the desert's organic dairy pasture is estimated to create $226 million worth of living and non-living resources in the natural environment, including $75 million in waste discharge management and $35 million in pasture creation and surrounding landscaping.

Source: "Oasis Pasture in the Desert - Natural Capital Evaluation of Mengniu Shengmu", 23 June 2021, https://www.csr-china.net/a/zixun/shijian/zrjzlal/2020/1223/5056.html.

Where are we now and where do we need to get to?

As China continues on its trajectory of long-term, high-speed economic growth, it faces severe ecosystem destruction and over-exploitation of its resources. Areas that are moderately or severely ecologically fragile now account for 55% of the nation's land area.[53] China has made great efforts and posted some achievements in ecosystem restoration and conservation, including delineating ecological conservation red lines,[54] protecting permanent basic farmland and various sea areas, and investing in the recuperation of grasslands, forests, rivers and lakes. To date, China has established more than 10,000 protected areas (PAs) of all types, including national parks and other categories of protected areas, accounting for about 18% of its total land area.[55] The initially delineated national ecological conservation red line area is not less than 25% of the country's entire land area.[56]

In June 2020, the *Master Plan for National Key Ecosystem Protection and Restoration Major Projects (2021-2035)* was released.[57] After a comprehensive consideration of the country's ecosystems, the continuity of natural geographical units and the sustainability of economic and social development, the plan proposes to implement important ecosystem protection and restoration projects mainly in three eco-zones and four eco-belts, as follows: the Qinghai-Tibet Plateau eco-zone, the Yellow River eco-zone (including Loess Plateau ecological function zone), the Yangtze River eco-zone (including Sichuan and Yunnan ecological function zone); and the Northeast forest eco-belt, the North combating desertification eco-belt, the South mountains and hills eco-belt and the Coastal eco-belt.[58]

China has made a start in ecosystem planning. In the coming 15 years, it will need to apply the strictest regulations and laws to protect the environment and strengthen the enforcement of rules, improve the coordination of territorial spatial planning, land development and ecological conservation,[59] and enhance the connectivity between existing protected areas. For this transition to be successful, the Chinese government must create incentives that reflect the true cost of destroying ecosystems. The government needs to make biodiversity economics and ecosystem accounting mainstream and establish an accounting system for natural assets and ecosystem services.

Aquatic species, especially marine species, are another issue of concern. In the future, China should partake further in negotiating a treaty for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction (BBNJ), alongside promoting the construction of marine national parks and the delineation and implementation of marine ecological conservation red lines.

For their part, businesses need to be active ecosystem restorers. In October 2021, the government issued the *Opinions of the General Office of the State Council on Encouraging and Supporting the Involvement of Non-governmental Capital in Ecological Protection and Rehabilitation*, which sets out the direction and mechanisms that all non-governmental sectors can undertake to "build an ecological civilization" through investments in the protection and restoration of nature.[60]

"For this transition to be successful, China must create incentives that reflect the true cost of destroying natural ecosystems. The government needs to establish an accounting system for natural assets and ecosystem services


GETTY/TATIANA DYUVBANOVA

Fresh vegetables and fruits at local market in Sanya, Hainan

In 2021, the International Union for Conservation of Nature (IUCN) released its *Guidelines for planning and monitoring corporate biodiversity performance* to help businesses identify and manage their impacts and dependencies on species, habitats and ecosystems.

Nature-based solutions are becoming an important part of the private sector's environmental actions: afforestation and reforestation,[61] land conservation and mangrove wetland restoration, to name a few. Ecotourism has also been a fast-growing emerging industry in China in recent years. In 2019, the number of trips to national forests in China hit 1.8 billion,[62] at an average annual growth rate of around 18%.[63] Eco-tourism is projected to create some $53 billion of additional revenue in China – providing the largest business opportunity in accelerated ecosystem restoration and avoided land and ocean over-exploitation.

2.3 Productive and regenerative agriculture

What is it?

The large-scale application of fertilizers, pesticides, herbicides and agricultural machinery may deliver short-term productivity gains in global agriculture, but it brings with it extensive negative impacts on agricultural ecology and the environment. Excessive consumption of resources and energy, along with the discharge of massive levels of pollutants, have led to major global environmental problems including ecological destruction, soil erosion, land degradation and biodiversity reduction, to name a few.

Regenerative agriculture with stable and high yields involves transforming agricultural landscapes, principles and practices, restoring soil fertility, improving water use and circulation, increasing agro-biodiversity of landscapes, and avoiding both offsite and onsite pollution. While ensuring the quality of agricultural products, it may even increase the yield and ecosystem resilience in some circumstances. This transition requires greater understanding and adoption of the appropriate agronomic solutions required to deliver sustainable nature- and land-based resource utilization.

FIGURE 8: **Productive and regenerative agriculture**

Farm household income and livelihoods

Regenerative agriculture can achieve stable or increased yields in the long term without expanding agricultural land. Cultivating the concept of green consumerism can increase consumers' willingness to pay for sustainable food, organic agricultural products and products certified by geographical indications. Farmers should be more integrated into the supply chain to ensure they receive a reasonable return.

Improved soil quality, water storage and carbon storage capacity

Reduce run-off sediment and nutrient loss; maintain soil fertility through no-till/less tillage, straw return and cultivating cover crops; adopt crop rotation to improve soil quality; develop circular agriculture; promote combination of animal husbandry and planting; increase soil carbon deposition; and improve soil with biochar.

Reduce pesticide and fertilizer application

Reduce chemical fertilizer while strengthening its effect, use green prevention and control, substitute with vegetable and tea organic fertilizer. Promote water-saving irrigation e.g. pipe irrigation, spray irrigation, micro-irrigation, agronomic techniques like integration of water and fertilizer.

Conserve and increase biodiversity

Interplant crops beneficial to pollinating insects; rationally plan the interplanting of native non-crop species (e.g. trees and shrubs) in and around farmland or pastureland; create farmland protection forests and forest corridors in and around farmland; restore and reconstruct river ecosystems.

Technological innovation and investment

Enterprises can further strengthen investment in scientific research, carry out technological innovation and promotion of good agricultural seeds, and reduce the need for land resources and chemical inputs. They can apply IT (e.g. remote sensing, internet of things) to remote diagnosis of animal and plant diseases, supervision of crop rotation, precise operation of agricultural machinery and drone technology.

CASE STUDY **Integrating planting and breeding to benefit from pasture manure**

Since 2013, Yili Industrial Group has been promoting an integrated, circular system of forage grass-planting and cow-breeding to address challenges faced by the traditional dairy farming industry, such as the difficulty in manure treatment and high feed costs. Manure on pastures is treated through the dry and wet separation process, or using oxidation ponds, after which the manure is used to irrigate the farmland. It is estimated that every tonne of straw-based fodder can replace 250kg of grain, while the nutrients provided by one tonne of manure are equivalent to that of 20 to 30kg of chemical fertilizer. By 2020, 272 partner pastures had been included in Yili's integrated farming system.

Yili's integrated farming model also contributes to the ecological restoration of grasslands. Ar Horqin Banner, Yili's main base for forage grass production, is located in China's northern ecological fragile zone. Due to frequent severe drought and over-grazing, pasture degradation and desertification became severe challenges. By planting pastures with alfalfa (one of the most nutritious forage grasses, which can promote the mineralization of soil nutrients)[64], Yili has improved 3,067 hectares of degraded grasslands, increased the vegetation coverage rate from less than 10% to more than 90%, and achieved an annual production of high-quality alfalfa and oat hay of more than 40,000 tonnes.

Source: Annual Report on Biodiversity Protection of Yili, 2020

CASE STUDY

Regenerative agriculture technology promotes soil health and a virtuous circle of farmland ecosystems

Huang-Huai-Hai region is the most important grain- producing area in China. In the past 40 years, the output of winter wheat has increased from 2.6 to 5.7 tonnes per hectare, and the total output represents 81% of the country's winter whea production. Yet due to the intensive monocropping of winter wheat and summer corn twice a year, both cultivated land quality and soil health in the North China Plain are declining, along with serious groundwater shortages. Years of unsustainable practice have seen agricultural machinery operations causing severe soil compaction, while the improper management of traw residues has exacerbated soil-borne diseases and pests. Although subsoiling and the deep burial of straw have been implemented, helping to address soil compaction and soil-borne diseases and pests, problems such as increased operational costs and field water loss remain.

In 2019, Syngenta Group China, China Agricultural University, The Nature Conservancy China and related government departments, collaborated on the MAP (Modern Agriculture Platform) and carried out research into and demonstration of conservation tillage and cultivation technologies in Huang-Huai-Hai region. Firstly, by using improved conservation tillage seeders, the operations of furrowing, seeding and suppression are completed in one step. This process has simplified the traditional seeding procedure (which used to require multiple machines), while minimizing soil erosion and soil disturbance by farm machinery, reducing greenhouse gas emissions from farm machinery operations, and cutting costs.

Secondly, the promotion of straw management technology and mulching of straw onto the soil has helped to improve soil water storage and moisture retention capacity, reduce soil wind and water erosion, provide more nutrients for soil micro-organisms (improving their biological activity), and reduce the use of chemical fertilizers and irrigation water. These approaches have improved the efficiency of water and nutrient utilization in the wheat-corn rotation area, promoted soil health, created a virtuous circle of farmland ecosystem management, while ensuring a high yield of crops and an increase in farmers' incomes.

According to experimental data provided by the project, compared with the local conventional agricultural operation, after a single season, conservation tillage can improve water storage in the soil by 7% on average, which is equivalent to 180 kg of additional water stored per hectare of soil. Nitrogen and phosphorus nutrients increased per year by on average 13% and 10% respectively, while soil carbon sequestration in the 0-40 cm soil layer rose by 7% on average, equivalent to an additional 4 tonnes of carbon sequestration per hectare. Meanwhile, management costs fell by around $240 (RMB1,530) per hectare, which coupled with the stable wheat yield led to an average gain in net income for farmers of almost $430 (RMB2,730) per hectare.

Source: This case-study is sourced from the introduction of the Runtian Program provided by TNC (The Nature Conservancy) China. Participants include the Agricultural Machinery Experiment and Appraisal Station of the Ministry of Agriculture and Rural Affairs, Syngenta Group China and TNC China. The data was measured by Prof. Ren Tusheng at the College of Land Science and Technology, China Agricultural University, based on the preliminary data of the Runtian Program.

Where are we now and where do we need to get to?

China has effectively achieved grain self-sufficiency.[65] However, the demand for soybean remains high, with annual consumption of around 110 million tonnes, over 80% of which depends on imports.[66] There is also a growing demand for beef and dairy products.[67] In order to ensure food security, China has implemented a system to protect its "red lines" of 120 million hectares of arable land. Yet the country's arable land is seriously degraded: two-thirds of it is medium- or low-yielding, while 14.5% of all arable land is acidified.[68] At the same time, China's crop diversity has dropped off dramatically. Rice varieties, for instance, fell from over 46,000 in the 1950s to just over 1,000 in 2006.[69]

Rice varieties in China fell from over 46,000 in the 1950s to just over 1,000 in 2006

The extensive application of fertilizers and pesticides is a serious problem. Before the launch of the *Plan for Zero Growth Rate of Fertilizer Use by 2020*, China consumed one third of all global fertilizers, with 328 kg average fertilizer use per hectare of crops (21.9 kg per mu) – 2.5 times the European average.[70] With the deepening of agricultural reform measures, by the end of 2020, the use of fertilizers and pesticides has fallen, as the application of mixed fertilizers based on soil testing represented over 60% of the total application of fertilizers within the three major food crops.[71] China also carried out conservation tillage of 9.33 million hectares, protected 6.66 million hectares of new northeast black land areas, and implemented new and highly efficient water-saving irrigation systems across 4 million hectares of cropland.

Regenerative agriculture with stable and high yields to secure food security requires government leadership, market orientation and social

involvement. China is accelerating the establishment of a modern agricultural industry system for green and low-carbon circular development. This involves greater efforts in conservation, better utilization of agricultural resources, the prevention and control of agricultural nonpoint (diffuse) pollution, and the protection and restoration of the agricultural ecosystem, with the aim of building a green and low-carbon agricultural industrial value chain.

In September 2021, the Chinese government unveiled its *14th Five-Year National Agriculture Green Development Plan*, which for the first time systematically planned for the green development of the country's agriculture sector. The plan proposes to implement the strictest possible system for protecting arable land, improving its quality and controlling areas of arable land that are deteriorating. By 2025, China aims to build a total of approximately 72 million hectares of high-standard farmland and treat about 1 million hectares of acidified and salinized arable land.[72] To succeed in these ambitious targets, the government needs to take the lead in improving the regulations and incentives for green agricultural development, such as revising the rules for crop disease and pest control and for ensuring the quality and safety of agricultural products.

Crop rotation and fallow systems should be implemented more widely, along with demonstration pilots for reducing the use of fertilizers and pesticides and increasing their efficiency. The government should also explore land fertility protection subsidies for arable land and promote comprehensive reform of the pricing of water for agriculture, to name a few priorities.[73] Farmers should be encouraged to carry out crop rotation, reduce the application of fertilizers and pesticides, return crop straw to farmland and increase the efficiency of water usage.

In the *First draft of the post-2020 global biodiversity framework*, issued by the secretariat of the UN Convention on Biological Diversity, Target 18 proposes to reduce incentives harmful for biodiversity by at least $500 billion per year.[74] To secure this target, the redirection of government resources towards new agricultural practices such as regenerative agriculture would show pragmatic support for such a target.

As a key stakeholder, agricultural businesses in China have started to transform their business models. Large corporations are developing smart agriculture practices with new technologies such as big data and the internet of things. Smallholder farms are also exploring regenerative agriculture techniques. But these practices can be further mainstreamed through stronger capacity building (e.g. communication campaigns, training and exchange) as well as more investments in infrastructure. Demand-side behavioural change also plays an important role. Encouraging greener lifestyles among the public can fuel support for mainstreaming regenerative agriculture.

Rice terrace in Yunnan,China

GETTY/YAORUSHENG

2.4 Healthy and productive oceans

What is it?

Maintaining a healthy and productive ocean requires restoring and managing marine areas that are already exposed to environmental pollution and ecological destruction, curbing the irrational exploitation of marine resources, and pursuing the sustainable management of wild fisheries.

For this transition to be successful, first, greater efforts are required to prevent and control land-based pollution from industry, agriculture and urban life, to lessen the impact on the marine environment and enable it to maintain its self-purification ability. In addition, the government should:

- Establish fishing moratoriums and limitations to maintain a balanced marine ecology and the sustainable utilization of marine biological resources
- Develop sustainable aquaculture in water ecosystems to put less strain on wild marine aquatic resources (e.g. in-plant recycling aquaculture[75] and multi-nutrient integrated aquaculture in seawater ponds)[76]
- Explore scientifically controlled sustainable ecological fisheries such as marine pastures and deep-sea green farming, to ensure stable and sustained growth of aquatic resources, alleviate degradation of key ecosystems, and allow fisheries suffering from overfishing to recuperate
- Restore coastal wetland ecosystems, by working with the aquaculture industry, which stands to benefit enormously from restoration

Finally, the impacts of other ocean industries, such as renewable energy (e.g. offshore wind), marine transportation and mineral extraction must be considered.

CASE STUDY

Blue Bay remediation action project in Dongtou, Wenzhou

Dongtou District, Wenzhou, located in the south-eastern coastal province of Zhejiang, boasts a unique endowment of marine resources with a coastline of 351 km and an expanse of sea representing nearly 95% of its total area. Yet as economic and social development has accelerated in coastal areas, the conflict between development and protection of marine resources has become increasingly prominent. Pollution of coastal waters has not been effectively curbed. Coastal landscape beaches are frequently affected by typhoons, storm surges and other disasters. The damage caused by illegal sand mining and other human interference is increasing day by day. The shoreline landscape is badly fragmented, presenting a shabby appearance.

In 2016, Dongtou launched the Blue Bay remediation action project. Since then, the district has restored 105,000 m^2 of beaches, built 23 km of marine ecological corridors and planted 28 hectares of mangroves. To repair the degraded marine ecosystem, the Lingni Levée was broken to reconnect the "two seas" that had been artificially separated for 15 years. The breeding habitat of perch, anchovies and other creatures in the Oujiang River basin has also been restored. Meanwhile, the planting of mangroves has enriched the biodiversity of the intertidal zone.

Taking advantage of Wenzhou's flourishing private sector, the Blue Bay remediation action project successfully attracted private capital into marine ecological restoration and engaged the participation of more than 10 private businesses, based on the principle that "whoever engages will benefit". The project involves cooperation on a variety of initiatives, including coastal tourism and sustainable aquaculture. Local villagers have benefitted from their role in the construction of supporting land-based facilities and subsequent operations. Local governments have offered to buy back the beaches repaired by businesses after the stipulated time specified in the contract, which allows those companies to turn a profit.

Since the Blue Bay remediation action project was launched, more than 20 species of resident migratory birds have been attracted to the mangrove and salt marsh wetlands, and the seaweed farm has naturally recovered to an area of 3,000 m^2. The extent of Class I and Class II seawater in the surrounding sea area reached 94.8% in August 2020. Meanwhile, the forests of mangrove and *Tamarix chinensis* planted by the project can sequester almost 200 tonnes of carbon annually, while the brown alga *Sargassum fusiforme* can absorb nearly 14,000 tonnes of carbon annually.

Sources:

1."Typical Cases of Ecological Restoration in China (7) - Wenzhou Dongtou Blue Bay Remediation Action", 16 October 2021, https://xw.qq.com/cmsid/20211018A0A01000?f=newdc.

2. "The first cases of social capital participation in ecological restoration of national land", 17 November 2020, http://www.xinhuanet.com/gongyi/2020-11/17/c_1210890297.htm. 2020-11-17.

Where are we now and where do we need to get to?

China has been the largest producer of fisheries for 30 years, accounting for around 35% of the world's total.[77] Since 1994, China's offshore fishing has gone 50% over its annual allowable catch. For example, in 2010, China harvested some 12 million tonnes of marine fisheries,[78] while its annual marine total allowable catch (TAC) was around 8 million tonnes.[79] Fortunately, since 2015, the offshore fishing capture volume has steadily fallen, reaching 10 million tonnes by 2019.[80] However, since 2014, distant water fishing[81] has soared, with a total yield hitting 2 million tonnes, up 50% from 2007's levels.[82] To curb such overfishing, it is essential to impose a system of fishing moratoriums for an extended period.

Aquaculture can ease the strain on wild fisheries imposed by the demand for aquatic products. In 2020, aquaculture contributed 80% of China's aquatic output,[83] accounting for over 60% of global aquaculture volumes.[84] Yet aquaculture may be exposed to drug abuse, residue of feed and seedling bait, and other pollutants such as metabolic waste by fish. These problems not only reduce the output and quality of aquatic products, but also cause serious environmental pollution and endanger human health. In 2019, the Ministry of Agriculture and Rural Affairs issued guidelines to address these issues, entitled *Several Opinions on Accelerating the Green Development of Aquaculture.*[85]

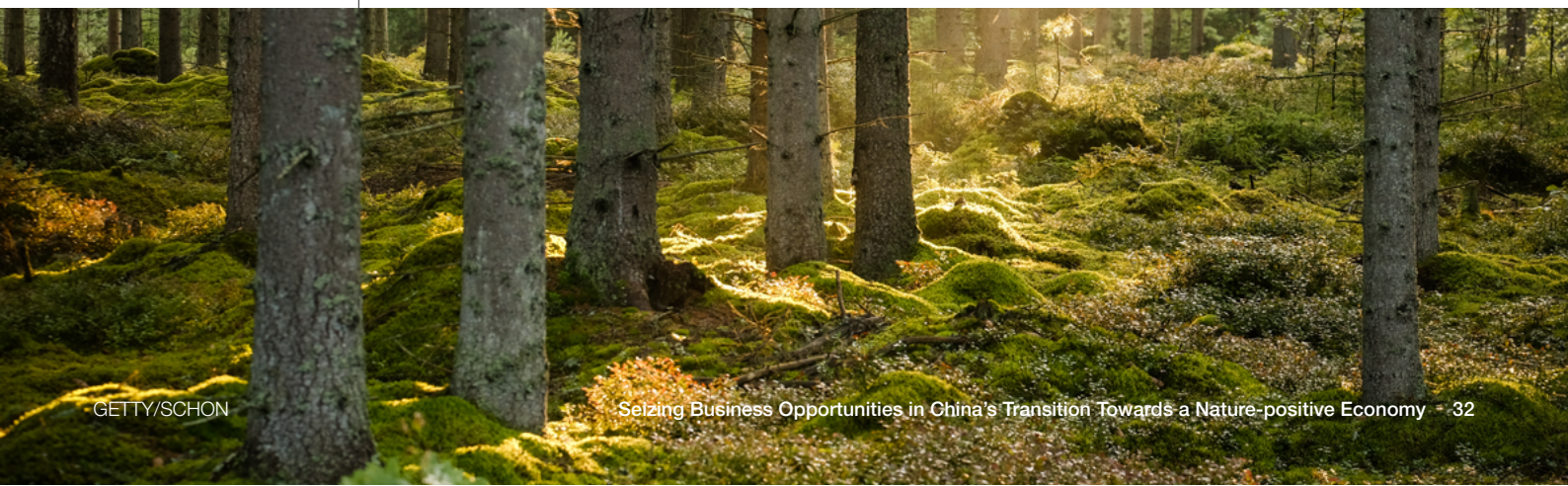
As the demand for aquatic products grows, the customs inspections and quarantine regimes of importing and exporting countries, as well as standards among buyers, are becoming more stringent. This in turn exposes China to higher requirements for aquaculture environment and production management. In the future, aquaculture is well positioned to relieve the pressure from marine fishing in China. But to achieve nature-positive fisheries requires a range of proactive policies, including promotion and certification of sustainable aquaculture, better planning for stocking density, optimization of aquaculture spatial layout, treatment of tail water and waste, and the restoration of water ecology.

2.5 Sustainable forest management

What is it?

Healthy forests stabilize the soil, prevent soil erosion and conserve water. They are home to an estimated 80% of the world's biodiversity[86] and provide an important carbon sink. To control global warming below 2°C, forests can provide one-third of the emissions reductions required by 2030, through absorbing atmospheric carbon.[87] Some 1.6 billion people worldwide depend on forests for food, energy and income.[88]

Sustainable forest management not only strengthens the forest's ecological functions such as cleaning water, maintaining soil, purifying air, sustaining biodiversity and regulating the climate, but also addresses the demands of society and the economy, including the income of forestry practitioners. To secure this transition towards sustainable forest management, the first step is to protect ecological forests with high conservation value, such as natural forests, water conservation forests and shelter forests in key ecological locations. Another way is to plant productive forests, such as commodity forests, and to promote close-to-nature management of artificial timber plantations. "Forest economies" offer a range of business opportunities, such as traditional Chinese medicine, beekeeping, wellness, leisure and sightseeing. The value of forest economies can be maximized by promoting secondary processing of forest products, recycling forest waste, developing woody oil and wood-based food, and diversifying non-timber forest products. Lastly, certification needs to be mainstreamed to further standardize sustainable forest management.



GETTY/SCHON

CASE STUDY

Forest Eco-Bank promotes scaled and specialized sustainable forest operation

China's collective forestry tenure system underwent major reforms over the past four decades. As the collective ownership of forest remained unchanged, the contractual management rights of forests were transferred to farm households through family contracting. Before the reform, China's collective forest land accounted for 60% of the country's forest land area, and the collective forest area involved 100 million households and more than 500 million farmers. After the reform, farmers are more motivated to plant trees, but challenges such as the fragmentation of forest tenure and the risk associated with land circulation continue to limit the effective and sustainable management of forests.

In 2018, the city of Nanping in Fujian Province launched the "Forest Eco-Bank". Through measures such as the buy-out of forest tenure, leasing or trusteeship, fragmented forest resources are centralized at the Forest Eco-Bank.

Nanping's Forest Eco-Bank optimizes the forest stand structure, increases forest stock and improves forest quality by changing single-layer forest into multi-layer uneven-aged forest. It also changes single coniferous forest into mixed coniferous and broad-leaved forest, and general timber forest into special local rare timber forest. Through sustainable forest certification and diversified businesses such as timber management, bamboo and wood processing, forest economy, wellness business and forestry carbon sequestration, the Eco-Bank enables forest resources to be utilized more effectively and sustainably.

Compared with decentralized management by farmers, the centralized management of the Forest Eco-Bank allows the forest management to be more scaled and specialized, improving the quality of forest resources, the value of assets and the carrying capacity of the ecosystem. The annual growth of forest stock now exceeds 18m^3/hectare and timber output is up by 25%. The non-timber forest-based economy management area is now 115,500 hectares, delivering a total economic output of $2.86 billion in 2019.

Source: Ministry of Natural Resources, Case studies of Ecological Product Monetisation - "Forest Eco-Bank in Nanping, Fujian Province", http://static.hxland.com/archive/02fda0ced93abe04b1d6a80d40bd2dad.pdf.

Where are we now and where do we need to get to?

China has put forest resources under special protection for more than two decades.[89] In addition to the stringent logging ban, China has launched large-scale afforestation, with an average annual afforestation rate of 6.6 million hectares and a preserved area of plantations of up to 69.33 million hectares,[90] securing an effective increase in the total volume of forest resources. China's forest area has hit 220 million hectares, with forest coverage up from 8.6% in 1949[91] to 23% in 2020.[92]

Yet the forest coverage target of 26% by 2035[93] and the annual afforestation target to plant more than 6.67 million hectares a year[94] require not only careful land planning but considerable investment. It is therefore essential for businesses, individuals and social organizations to invest in forest construction. The Chinese government is strengthening the sustainable operation of forests by developing policies of land tenure and forest operations, and advancing the compensation mechanism for ecological public-welfare forests.

Non-timber forest-based economy[95] are an effective lever to enhance the economic value of forests. The total value of the non-timber forest-based economy in China was $150 billion in 2019.[96] The country's latest *Forest Law,* taking effect in July 2020, defines the legal status for the development of the non-timber forest-based economy. The *Guideline for the Development of National non-timber forest-based economy (2021-2030),* published in November 2021, provides clearer guidance for regional industrial planning, key development areas and typical business models. It also proposes a goal for the output value of China's non-timber forest-based economy to exceed $200 billion by 2030.[97]

Certification for sustainable forest management by China's Forest Certification Council (CFCC) brings greater market premium to productive forests and forest economies. For example, CFCC-certified non-wood forest products are sold at a 1.5- to 4-fold premiums, while CFCC-certified wood commands 10% higher prices than common wood.[98] Yet the ratio of certification under a range of domestic and international schemes (e.g. the Forest Stewardship Council (FSC), the Programme for the Endorsement of Forest Certification Schemes (PEFC) and CFCC) remains low at less than 3%.[99] The development of sustainable forest operations in China requires greater efforts in certification.

"The total value of the non-timber forest-based economy in China was $150 billion in 2019

2.6 Planet-compatible consumption

What is it?

While the four transitions discussed earlier have dealt with where and how we *produce* agricultural, fisheries and forest products, nature-compatible consumption addresses how we *consume* these products, such as through food and natural fibre. For example, the excessive consumption of red meat and processed meat products is not only harmful to health – increasing the incidence of cancer and heart disease – it also imposes a burden on the natural ecological environment. Livestock takes up 80% of global agricultural land[100] and creates 15% of global man-made carbon emissions, equivalent to all exhaust emissions in the global transport industry.[101] We must accelerate the transitions towards sustainable consumption and choose green, low-carbon agriculture, forestry, animal husbandry and fishery products with less impact on the ecological environment.

China should develop green, organic and GI-certified (indicating geographical origin) agricultural products, promote alternative protein and plant-based foods, and encourage its citizens to shift a greater proportion of their diets towards vegetables, fruits and nuts. Consumer education is needed to foster healthy and green consumption. Carbon footprint, water footprint, sustainable certification and other tags can be used to build a demand engine for more nature-positive agriculture, forestry, animal husbandry and fishery products. It is also necessary to discard throw-away models of daily consumer goods (e.g. fast fashion) in favour of more durable models that consume less natural fibre and biological resources. With efforts in both supply and demand, nature-compatible consumption can prevail in China.

Where are we now and where do we need to get to?

Some 17 to 18 million tonnes of food go to waste in China's urban catering industry alone every year – enough to feed 30 to 50 million people.

China will need to sustain growing demand for food and natural fibre as living standards improve and eating habits change. China consumes 28% of the global meat supply, including half of its pork.[102] Its total consumption of beef has soared, with beef imports doubling from 2018 to 2020,[103] although the average beef consumption per capita in China remains much lower than in other developed countries. In 2018, China consumed 50% of the beef exported by Uruguay and Argentina. China has now become one of the most important buyers for South American beef. [104]

Waste consumption in the food and textile sectors is another challenge for China. Some 17 to 18 million tonnes of food go to waste in China's urban catering industry alone every year – enough to feed 30 to 50 million people.[105] Curbing such waste would also lighten the additional burden on the environment arising from the unnecessary waste of primary resources such as water, energy, fisheries and land.

In China's textile sector, 35 million tonnes of fibre are consumed each year, accounting for one-third of global fibre production,[106] while annual textile waste totals 20 million tonnes, about 20% of the global total.[107] Yet the recycling rate is less than 20%.[108] Accelerating the substitution of raw materials, promoting energy saving and consumption reduction, and strengthening the resource utilization of waste are effective ways to push forward the circular model in the textile industry. If 60% of waste textiles were recycled and comprehensively utilized,[109] it would supply an annual output of about 9.4 million tonnes of chemical fibres and about 4.7 million tonnes of natural fibres. This would save the equivalent of 18.8 million tonnes of crude oil and over 6 million hectares of land, thereby effectively alleviating the problem of resource scarcity in China's textile industry.

China is shifting towards nature-compatible consumption. The Clean Plate Campaign, first launched in 2013, has turned food waste into an issue widely recognized and addressed by the public. In 2021, the *Anti-food Waste Law of the People's Republic of China*[110] was issued to apply legal sanctions to prevent food waste. These measures could make a meaningful contribution towards China's commitment to halve food waste at the consumer level by 2030. In recent years China has promoted the public-welfare recycling of old clothing and the prevention of over-packaging in the delivery sector to curb waste. A national nutrition plan[111] for all-round nutritional health has been launched. Furthermore, alternative protein, plant-based foods and lab-grown meat are also increasingly attracting attention from investors and consumers in China.

2.7 Transparent and sustainable supply chains

What is it?

> China's annual grain loss in the post-production process – during storage, transportation and processing – is around 35 million tonnes,[112] enough to meet the daily grain needs of 385 million people per year.

Supply chains in the agriculture, forestry, animal husbandry and fishery sectors are complex and lack international harmonization, leading producers to exploit loopholes and operate illegally or unsustainably. Yet consumers, investors and regulators are increasingly demanding more information about the environmental and social impacts of the products they consume, invest in and regulate. Food loss in supply chains, for example, is huge. Therefore, integrating greater transparency, traceability and upstream-downstream collaboration into supply chains will improve their sustainability and legality by promoting innovation at storage and transport levels.

For this transition to be successful, the environmental, social and economic impacts related to suppliers and their production processes must be comprehensively managed. This transition requires the following:

- Promoting new varieties, technologies and equipment to reduce food waste during production, harvest, transport, storage and consumption
- Developing direct supply modes and establishing a transparent traceability system for agricultural products
- Pushing sustainable supply-chain certification of commodities such as palm oil, soybeans, beef and forest products to be aligned with international standards; this will reduce deforestation risk in both upstream and downstream supply chains

CASE STUDY

Food Bank storage model and innovative food transport reduce loss in supply chains

China's grain loss in the post-production process is significant, especially during the stages of storage, transportation and processing. The annual loss is around 35 million tonnes. Assuming daily grain intake per person on average is 250g and annually 91kg, this loss would be enough to meet the daily grain needs of 385 million people per year. COFCO, China's largest food company, has launched a Food Bank storage model. Through contractual agreements with cooperatives, household farms and large grain growers, COFCO provides farmers with comprehensive services including agent drying, agent storage, settlement in batches and financial support based on its drying facilities and storage resources. By doing so, grain can be stored directly from the fields with almost zero loss, avoiding problems such as grain loss and mildew caused by unfavourable storage.

COFCO has also innovated in its modes of grain transportation. For a long time, packaged grain transport was the dominant method in China. This involved unpacking grain in storage and packing grain again in transit and transport, leading to a high loss rate of over 5% in the process of handling and transport. COFCO has pioneered an unpackaged grain logistics system throughout the whole process of handling, storage and transportation. COFCO has also stepped up the construction of bulk grain facilities in major logistics channels and nodes. This reduces the loss of grain in circulation and features a high degree of mechanization, modernizing China's grain logistics system.

Source: "COFCO Explores 'Full Chain', Huge Room for Improvement for Food Saving", 2020, http://www.cofco.com/cn/News/Allnews/Press/2020/0907/49605.html.

CASE STUDY

"Deforestation-free" soy procurement uses satellite imagery to ensure sustainable supply chains

Global annual consumption of food and agriculture products rose by 48% between 2001 and 2018 – more than twice the rate of the increase in human population. China is a big consumer of agricultural commodities, contributing 22% to its growth. Tropical deforestation caused by unsustainable supply chains has attracted worldwide attention. Responsible supply-chain management by businesses in China is crucial for strengthening China's sustainable agricultural consumption.

COFCO International (COFCO's platform for the unified procurement, deployment, investment and development of international agribusiness) has taken the lead in the due diligence and traceability tracking of the green soybean value chain from Brazil. The company has improved its value chain sustainability by delinking soft commodities from deforestation. COFCO International is strengthening deforestation-free practices in its supply chain by setting a "cut-off" date and committing to only purchasing deforestation-free commodities after the "cut-off" date in a given biome or smaller region. For example, the cut-off date for deforestation-free soy in the Amazon biome is July 2008.

The company is also asking suppliers to provide the boundaries of their farms, ranches and jurisdictions from which they source, and then employs satellite imagery to monitor the adherence of those suppliers to the deforestation-free objective. In 2020, COFCO International mapped and analysed 357 supply farms in Brazil – covering nearly 428,000 hectares – and achieved 100% traceability in all 25 priority municipalities ahead of schedule. It also actively cooperated with suppliers, such as providing them with technical and economic assistance, to increase the output of their existing cultivated land and pasture.

In 2019, COFCO International received a $2.3 billion sustainability-linked loan facility from a consortium of 21 banks.

Global annual consumption of food and agriculture products rose by 48% between 2001 and 2018 – more than twice the rate of the increase in human population

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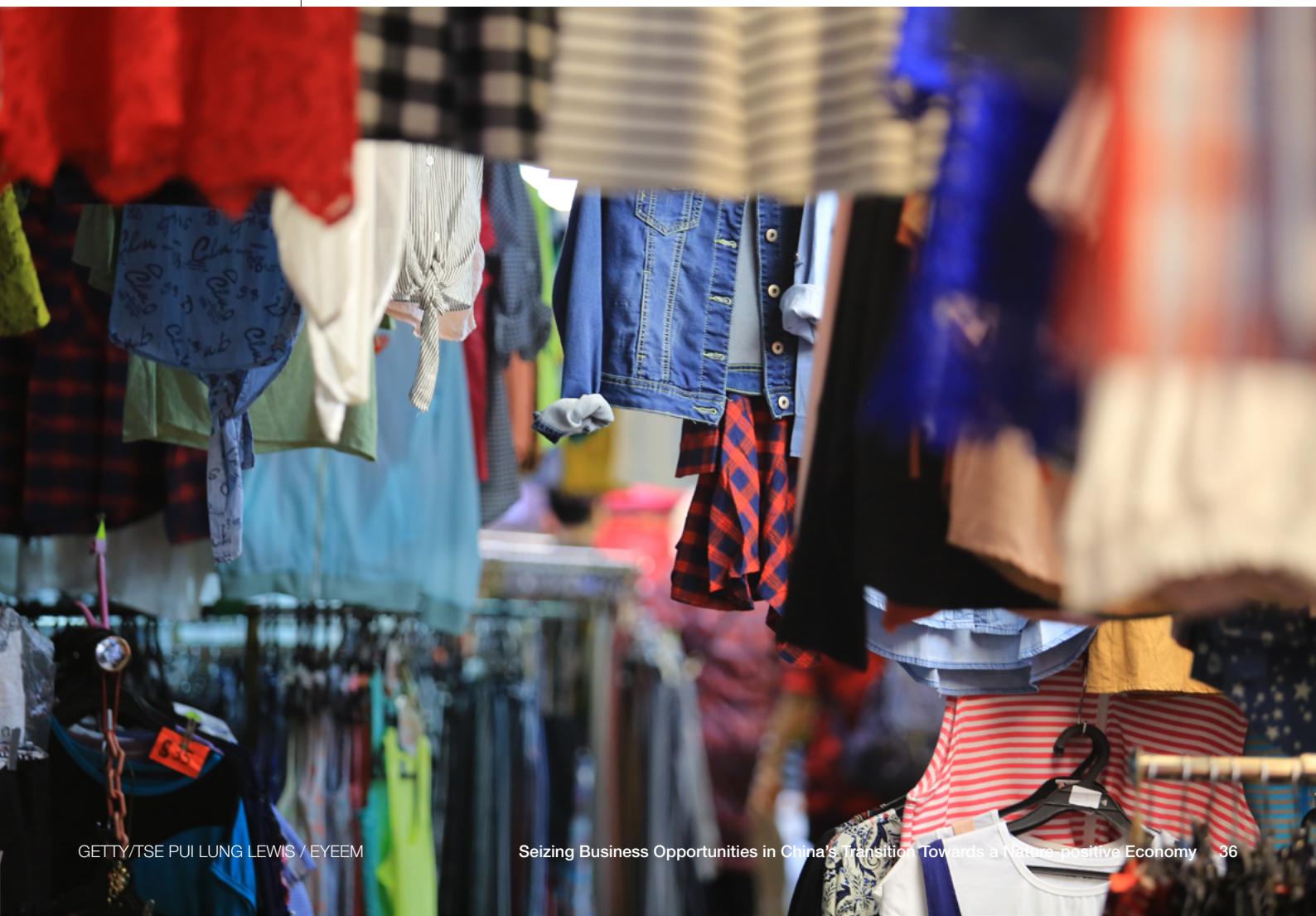
2. "COFCO international successfully completes USD 2.3 billion sustainability-linked facilities", COFCO International, 23 July 2019, https://www.cofcointernational.com/newsroom/cofco-international-successfully-completes-usd-23-billion-sustainability-linked-facilities/



Clothes hanging at market stall for sale, China

GETTY/TSE PUI LUNG LEWIS / EYEEM

Where are we now and where do we need to get to?

China faces many sustainability problems in supply chains in the food, land- and ocean-use system. Curbing waste is the top priority. In China, 350 million tonnes of food in supply chains are lost or wasted, representing 27% of total food production for human consumption[113] – a huge loss for producers as well as for the sustainability of resources and the environment. Deforestation in supply chains for soft commodities such as soybean, beef and palm oil is another challenge.

In China, 350 million tonnes of food in supply chains are lost or wasted, representing 27% of total food production for human consumption

Building transparent and sustainable supply chains requires both government and business efforts. China has raised the fight against food waste to the level of legal governance. At the Glasgow Climate Change Conference (COP26), China signed a declaration committing to halt and reverse deforestation by 2030, to demonstrate its strong willingness to act on issues such as global ecology and climate change. In this context, Chinese businesses need to complete their transition to transparent and sustainable supply chains within the next decade.

Progress is needed on multiple fronts. Government and businesses alike need to turn their commitments into practical actions, for example in establishing and improving the policy, standards and monitoring systems for grain saving and loss reduction.[114] In the field of soft commodities, all key stakeholders including government, traders and consumers must make the shift towards sustainable sourcing. The Tropical Forest Alliance (TFA) has a created multi-stakeholder platform to catalyse the discussions and actions on policy-making, sustainable sourcing sectoral specifications, business capacity building, product traceability and data transparency, innovative financial instruments and technology solutions, as well as bilateral and multilateral exchanges along supply chains. These discussions and collaborations among stakeholders will help Chinese businesses to contribute towards the global target of forest protection.

2.8 Future business opportunities

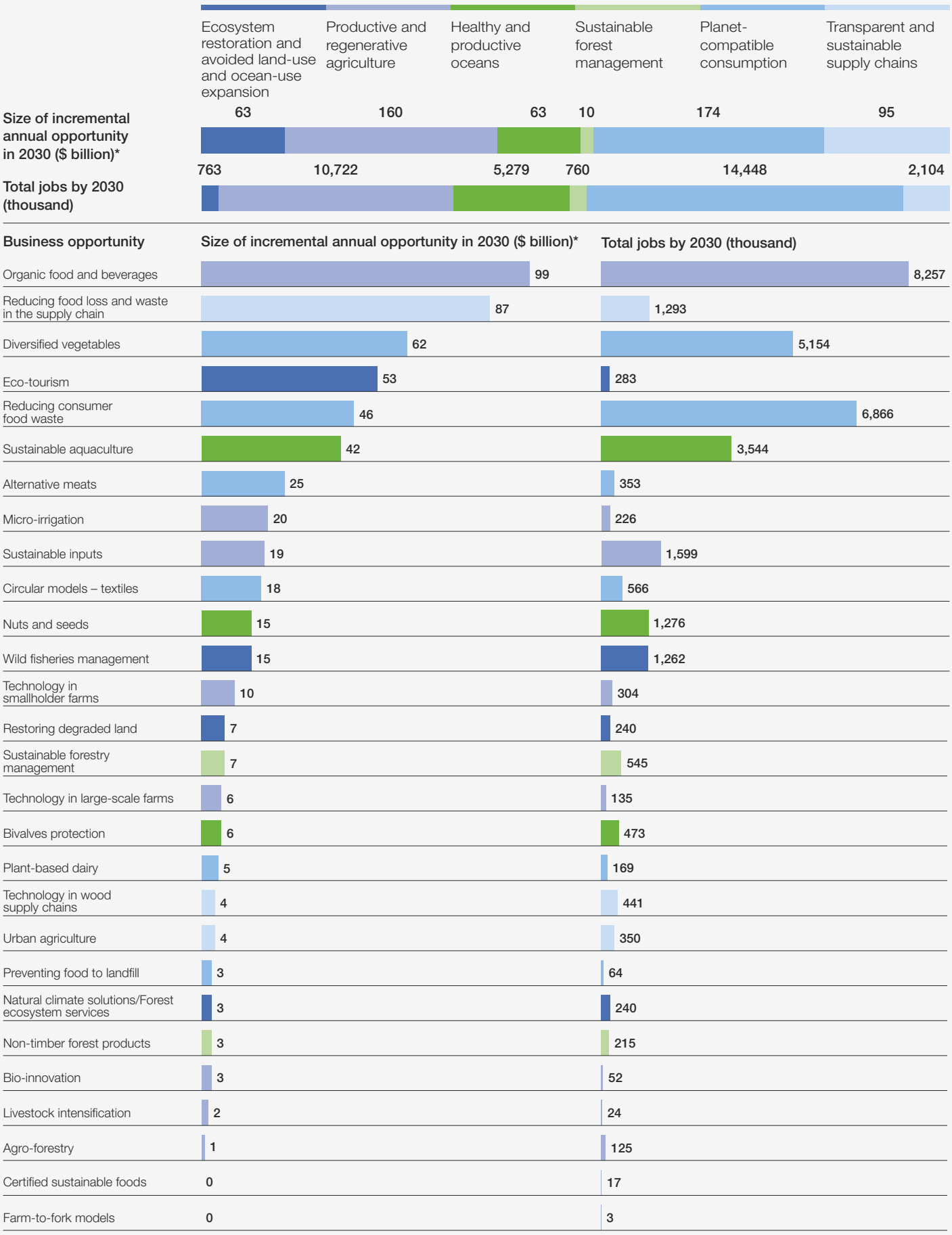
Through technological innovation and investment in a nature-positive food, land- and ocean-use system, business opportunities across these six transitions in China could create around $565 billion worth of value and 34 million jobs by 2030.[115] Business opportunities across these six transitions involve a variety of fields, from organic food and beverages to ecotourism and alternative meat (see Figure 9).

The six transitions proposed for China's food, land- and ocean-use systems could create $565 billion of annual business value and 34 million jobs by 2030

Crescent Lake in Dunhuang, Gansu Province

GETTY/RICKWANG

FIGURE 9 | **Business opportunities and jobs arising from the transition of the food, land- and ocean-use system**



* Based on estimated savings or project market sizing in each area. These represent revenue opportunities that are incremental to business-as-usual scenarios. Where available, the range is estimated based on analysis of multiple sources. Rounded to nearest billion.

Sources: Food and Land Use Coalition (FOLU); Business and Sustainable Development Commission (BSDC); The Nature Conservancy (TNC); World Resources Institute (WRI); McKinsey Global Institute (MGI); market research; literature review; AlphaBeta analysis.

Organic food and beverages

The organic food and beverages sector offers the largest business opportunity under the transition to regenerative agriculture with stable and high yields. This sector is projected to create $99 billion worth of value and 8.25 million jobs by 2030. Since the publication by the government in 2017 of the influential *Opinions of the General Office of the CPC Central Committee and the State Council on Deepening Supply-side Structural Reform in Agriculture and Accelerating the Cultivation of New Growth Engines in Agriculture and Rural Areas*, the labelling of more agricultural products as organic or green has become the focus of agricultural reform[116] and China's organic food industry has entered a golden period of development.

From 2015 to 2019, the average annual growth in the number of organic product certificates issued (a measure for the supply of organic products) was 13.7%, with the total number of new certificates hitting 21,764 in 2019. Meanwhile, the area under cultivation of certified organic food in China has increased over 60% between 2017 and 2019. China's certified organic food area reached 34 million hectares in 2019, an increase of 13 million hectares from 2018.[117]

From 2013 to 2019, the market value of the organic food industry soared from $4 billion to $9.8 billion, at a compound annual growth rate of 15.9%.[118] Additionally, driven by greater awareness of food safety and health care, citizens are increasingly demanding organic food. Under the guidance of Chinese-related policies, the organic food and beverages sector looks set for a promising future. Maintaining this trend will require ongoing efforts to invest in scientific research, management innovation, market education and sales networks.

Diversified vegetables

China ranked No. 1 globally in vegetable export values in the decade from 2009 to 2019.

The basket of vegetables should be diversified. China is a major producer, consumer and exporter of vegetables. It produced 749 million tonnes of vegetables in 2020 and is expected to consume 739 million tonnes in 2021.[119] China is one of the world's top exporters of vegetables by volume, with export flows in 2020 of 10.1 million tonnes worth $11.9 billion,[120] ranking No. 1 in vegetable export values in the decade from 2009 to 2019.[121]

Fuelled by stronger demand for healthy nutrition, vegetable consumption will continue to climb. Demands for brand vegetables, conveniently processed vegetables and high-quality vegetables will grow[122] and given its huge potential for vegetable exports,[123] China will embrace a promising diversification landscape. Given its great potential to increase the mechanized production, certification and branding of vegetables, China can secure its future business opportunities by improving the industry's supply chain and nurturing more market players with modern production and operation capabilities.

Ecotourism

Ecotourism offers another promising business opportunity. China has fostered a series of ecotourism destinations comprising nature reserves, scenic areas, forest parks, geological parks, wetland parks, desert parks and water conservancy scenic spots, covering mountains, forests, grasslands, wetlands, oceans, deserts and human ecology.[124] Ecotourism has become an important contributor to China's national economy. In 2019, the number of forest tourism trips in China reached 6 billion with an average annual growth rate of 15% from 2015 to 2019.[125]

In 2021, the Chinese government issued its *Opinions on Establishing and Improving the Mechanism for Realizing the Value of Ecological Products*, setting out the means for developing eco-friendly production and lifestyles by 2035,[126] which in turn are expected to fuel the market-orientated development of ecotourism. At the same time, China's rural area revitalization strategy brings a new opportunity for rural ecotourism.[127] Backed by the government's protection system focusing on ecological protected areas and national forest parks, the policy environment favours the further growth of business opportunities in ecotourism.

3 Nature-positive infrastructure and the built environment

Vertical forest green building in Chengdu, Sichuan Province

GETTY/VCG

China's rate of urbanization has grown from 10.6% at the end of 1949[128] to 63.9% in 2020.[129] On current projections, it is expected to rise to 75% by 2030.[130] Extensive urban development has aggravated environmental pollution, ecological destruction and traffic jams in urban and surrounding areas. Studies show that unscientific land- and traffic-planning will result in traffic congestion, time loss, fuel waste and air pollution, likely to lower the national GDP by 5%.[131] Urban pollution and traffic jams have also had a negative impact on the physical and mental health of urban residents.

Among China's 97 national economy industry categories, 20 industries are in the infrastructure and built-environment system, relying on natural resources such as water, air, land and building materials to sustain their development. This system generates solid waste, wastewater and exhaust gases, which are highly likely to have a negative impact on nature. With the rapid development of China's economy and growing urbanization, the negative impacts of this system will become increasingly visible. The transition towards nature-positive infrastructure development is therefore an urgent priority.

The World Economic Forum's report *BiodiverCities by 2030*, makes the case for a new urban paradigm where there is more nature in cities: by combining nature-based infrastructure and land-sparing interventions, cities can optimize both investment and benefits for a nature-positive future. The report finds that spending $583 billion on nature-based solutions for infrastructure and on interventions that release land to nature could create more than 59 million jobs by 2030, including 21 million livelihood-enhancing jobs dedicated to restoring and protecting natural ecosystems.

3.1 Five priority transitions – a summary

Five priority transitions can set China's infrastructure and built environment system on a pathway towards nature-positive development.

The transitions are summarized in this section below and each is addressed in greater detail in subsequent sections of this chapter:

1. Compact built environment
2. Nature-positive built-environment design
3. Planet-compatible urban utilities
4. Nature as infrastructure
5. Nature-positive connecting infrastructure

1. Compact built environment

A compact built environment should be created on the basis of scientific master-planning on space and land use, as well as public transportation-orientated development patterns. From 2009 to 2016, China's urban land area grew at an average annual rate of 3.8%,[132] yet urban housing is not being efficiently utilized: the overall vacant housing rate in urban areas reached 21.4%.[133] As of November 2021, there were 393 million motor vehicles in China[134] and the shortage of parking facilities has become a major problem. More efficient use of idle urban land to develop a compact built urban space could reduce the demand for new land use by up to 75%.[135] In future, China should seize the business opportunities of shared accommodation, shared office facilities, shared parking lots and smart parking technologies to enhance housing and land utilization and to slow down urban sprawl.

FIGURE 10: **Five transitions and 20 industries within the infrastructure and built-environment system**

Sector role in transition: Principal / Enabling

Sectors	Transitions: Compact built environment	Nature-positive built-environment design	Planet-compatible urban utilities	Nature as infrastructure	Nature-positive connecting infrastructure
Housing construction	Principal	Principal		Principal	
Civil engineering construction	Principal	Principal	Principal	Principal	Principal
Construction and installation			Principal		
Building decoration, decoration and other construction					
Waste resources comprehensive utilization			Principal		
Water production and supply			Principal		
Railway transport					Principal
Road transport					Principal
Water transport					Principal
Air transport					Principal
Pipeline transportation			Principal		
Multimodal transport and transport agency					Principal
Handling and storage	Principal				Principal
Telecommunications, radio, television and satellite transmission services			Principal		
Internet and related services			Principal		
Software and information technology services			Principal		
Real estate	Principal	Principal			
Leasing	Principal				
Culture and art			Principal		
Sports			Principal		

Sources: Industrial classification for national economic activities (GB/T 4754—2017), World Economic Forum, GoldenBee analysis.

2. Nature-positive built-environment design

Implementing a nature-positive approach to planning and designing the built environment is another key priority. When determining the location of infrastructure projects, schemes with zero or minimal ecological impact should be preferred. By selecting sustainable materials and energy-saving equipment, and by calculating the environmental impacts of each component of the building and its full construction cycle, cities can expand their green spaces, protect their biodiversity and even create urban forests. Today, green energy-saving buildings, green roofs, smart meters and prefabricated buildings are all available in China. There is much scope for improvement, given that the green-roof area in large and medium-sized Chinese cities currently accounts for just 1% of the total roof area of each city.[136]

3. Planet-compatible urban utilities

The development of planet-compatible municipal public facilities is vital to manage and reduce air pollution, water pollution and solid waste. With solid-waste streams expanding by 10 billion tonnes a year,[137] China is still underdeveloped in its treatment of solid waste, 95% of which was treated by incineration and landfill in 2020.[138] Authorities should focus on three key areas of municipal public facilities:

- Strengthening the construction and transformation of urban waste pipe networks
- Building a "sponge city"[139]
- Reducing waste flows and recovering resources from sewage and solid waste, and improving levels of waste detoxification

4. Nature as infrastructure

Infrastructure designers should learn from nature as the "original designer" of planet-compatible infrastructure. For example, incorporating wetlands and forests into the built environment could reduce the demand for man-made engineering schemes. Over the past two decades, nearly 400 cities in China have joined the campaign to build "national forest cities."[140]

Meanwhile, China's coastal ecosystem has been repaired and restored through measures such as reinstating natural coastlines, restoring wetlands and removing dykes and seawalls to restore marine environments. Experience shows that treating nature as infrastructure can not only play an important role in mitigating climate change, it can also cut costs and create considerable benefits. For example, by 2030, nature-based water-supply solutions are projected to save $21 billion annually.

5. Nature-positive connecting infrastructure

The final priority transition is to develop nature-positive connecting infrastructure, by strengthening the ecological optimization of new routes for transportation that adopt "hazard-free" technologies and standards for crossing ecologically sensitive regions, using environmentally-friendly durable materials, promoting clean energy, reducing the impacts of infrastructure on the environment and human health, and popularizing green long-distance transportation.

Special attention should be paid to the coverage of six major economic corridors following China's Belt and Road Initiative and the 265 threatened species along those routes. Biodiversity conservation must be regarded as one of the core construction concepts in future infrastructure projects.

3.2 Compact built environment

What is it?

In the process of global urbanization, the disorderly spread of China's built environment has greatly affected surrounding ecosystems. If cities continue to expand at their projected rates, approximately 2 million hectares of agricultural land will disappear every year globally.[141] Since China's economic reform and opening-up 40 years ago, the extent of urban land has increased over seven-fold. This is not a sustainable trajectory.[142] The transition towards a more compact built environment aims to accommodate greater amounts of population and infrastructure in smaller spaces, through scientific space and land-use planning.

To achieve this objective, municipalities must first implement a strategy focused on a compact built development and utilization of the existing built environment. Urban development boundaries should be defined to achieve "compact, moderate and green development".[143] Authorities can improve the efficiency of existing infrastructure by utilizing vacant housing and renovating or occupying under-utilized space, so that more green-field sites can remain pristine and undeveloped.

The second priority under this transition to ensure the design process focuses on creating compact new built environments, to include the planning of convenient and interconnected public green spaces. This can be achieved through a rational concentration of buildings and an improvement of public facilities, which in turn will create more liveable high-density cities, enhance biodiversity and reduce urban pollution and disease probabilities.

Where are we now and where do we need to get to?

From 2009-2016, China's urban land area grew at 3.8% per year, yet in 2018-19, 22% of its urban housing and office stock lay vacant

China's urban land area grew at an average annual rate of 3.8% during the eight years from 2009 to 2016.[144] Yet urban infrastructure utilization is not efficient. The urban vacant housing rate was 22.4% in 2018,[145] while the office vacancy rate was 22% in 2019.[146]

Studies indicate that, by changing the current state of urban sprawl and making full use of unused urban land to develop compact urban spaces, municipalities could reduce the demand for new land use by 75%.[147] It is crucial for the government to make compact planning of the built environment a priority and to implement guidance to reduce the vacant housing rate. China is actively promoting the supply-side reform of the real estate industry, while planning to implement a vacant housing tax and promoting the development of the "sharing economy" such as shared offices and shared parking lots.

Under the impact of COVID-19, technologies such as 5G, artificial intelligence and the internet of things have been widely used, accelerating the integration of online and offline services, speeding up the development of new modes of shared services and consumption, and bringing new opportunities for improving the utilization rate of the built environment and the resilience of the real estate economy.[148] In future, municipalities should do the following:

- Further delimit urban development in accordance with the requirements of "compact, moderate and green development"[149]
- Practice neighbourhood reform
- Clearly define the period and sequence for the development and utilization of construction land
- Improve the land price market-based mechanism
- Strengthen the legal system governing land conservation and intensive land-use

Meanwhile, pressure on parking facilities is growing: there was a shortage of 50 million parking spaces in 2020.[150] The compact and intensive development of parking facilities along with the integration of information technology into the parking industry are of great importance to reshape the land-use of parking lots and to reduce the land area consumed by parking.[151] It is estimated that by 2035, China will have completed an intelligent, efficient and convenient urban parking system, with reasonable layout and sufficient supply.[152]

3.3 Nature-positive built-environment planning and design

What is it?

Cities occupy just 3% of the earth's land area but consume 60-80% of the world's energy and contribute 75% of greenhouse gas emissions.[153] The promotion of the nature-positive built-environment planning and design transition will be a critical opportunity to achieve sustainable growth, improve efficiency and technological innovation, and reduce resource and energy consumption.

Nature-positive built-environment planning and design involves four major elements:

- **Select the best construction location.** By analysing the environmental impacts of different construction scheme options, the location with zero or minimal impact should be selected.
- **Systematize built-environment design.** Take into account and eliminate as far as possible the environmental impacts of each component of the building and its life cycle. Green spaces, including street scenes and roofs, should be carefully planned. Buildings should be made more sustainable by making the most of natural heating, refrigeration and illumination options, sustainable materials and energy-saving devices. The government should set standards for the whole process of design, construction, operation and renovation. Security should be offered through green finance and building technology.
- **Integrate the dual concepts of nature and habitation in the design**, to achieve harmony between protecting nature and benefiting citizens. For instance, an urban forest can reduce ambient temperatures and save 40% of air conditioning costs.[154] Expansion of green space can enhance the resilience of a city to natural hazards, while proving beneficial to the physical and mental health of residents.[155]
- **Smart metering should be popularized**. Information technology and smart technology should be closely integrated with urban development to provide a foundation of data and technology to support nature-positive planning and design.

CASE STUDY

Changzhen Project: towards a garden community with prefabricated construction technologies

With its huge demand for steel, cement and other building materials, the traditional method of construction generates a large amount of municipal solid waste, while often also polluting the surrounding environment.

The city of Shenzhen's Changzhen Project is the largest prefabricated community under construction in China. It uses prefabricated construction technology that does not require building materials such as cement, enabling it to minimize construction waste and onsite pollution. All panels are standardized in the factory, achieving a 35% prefabrication rate and 65% overall assembly rate. Green planting boxes have been used to green rooftops, increasing the area of urban green space and creating a garden-style community. The construction process, which uses building information modelling (BIM) and information supervision technology, is 30-50% shorter than before.

Changzhen is the largest public government-subsidised housing project in China, containing over 9,000 housing units, which will provide a high-quality living environment for nearly 30,000 people. Compared with traditional housing, the project consumes 20.5% less water, 7.5% less carbon and 77.7% less waste per square metre, lowering the project's negative environmental impact while saving costs.

The project has now been taken as a template for the Ministry of Housing and Urban-Rural Development to compile standardized specifications for prefabricated buildings. The project is also included in the *List of Replicable Experiences and Practices for Coordinated Development of Intelligent Construction and New Building Industrialization*. As an excellent model of prefabricated buildings, it can be used for reference by the whole industry.

Source: China Construction Science & Technology Group Co. Ltd., "Green, Intelligence, Technology, Humanity — Decoding the Shenzhen Changzhen Public Housing Project", 22 May 2020, http://ccstc.cscec.com/fwzq66/szczxm/202005/3084803.html.

Where are we now and where do we need to get to?

China's construction industry accounts for 26% of China's GDP. The industry's whole lifecycle carbon footprint – from the emissions generated by the production of construction materials such as cement and steel, and the construction process itself, to the day-to-day operational running of the buildings[156] – exceeds 50% of China's national carbon emissions.[157] Promoting green buildings has achieved remarkable results in reducing energy consumption and carbon emissions across the whole industry. In 2019, green buildings (defined as "buildings that save resources, protect the environment and reduce pollution in the full lifecycle") accounted for 65% of newly built construction areas in Chinese cities and towns. In the same year, the market share of energy-saving products exceeded 50%, indirectly accounting for about 75% of construction and industrial energy consumption.[158] The accumulated electricity saved through these products was equivalent to over 46% of urban and rural residents' power consumption in one year.

Nature-positive built-environment planning and design has huge potential to grow in China. In large and medium-sized cities, green roofing, for example, only accounts for 1% of the total roof area of each city.[159] By 2025, China is expected to have fully implemented green building standards for new urban buildings.[160] By 2030, if the refrigeration efficiency of large-scale public buildings increases by 30% and the market share of green and efficient refrigeration products rises by more than 40%, then the electricity saved every year could supply nearly one-third of all urban and rural residents with power for a whole year.[161]

In 2019, green buildings accounted for 65% of newly built construction areas in Chinese cities and towns

Residential complex and skyscrapers, Pudong, Shanghai

GETTY/FOTOVOYAGER

3.4 Nature-positive urban utilities

What is it?

The effective management of urban air, water and solid waste pollution is a mainstay to guarantee sustainable urban development, public health and social welfare. It is estimated that 80% of the world's wastewater is discharged untreated into freshwater, which is then used to irrigate cropland, and into coastal ecosystems.[162] Most urban waste, especially plastic waste, is piled up in landfill or discarded into the natural environment (mainly the ocean), which not only threatens wildlife but also forms microplastics damaging human and animal health.

Urban authorities should focus on the following three priorities to create nature-positive urban utilities:

- **Pipeline networks**: Strengthen the construction, renovation and inspection of underground pipeline networks, including urban water supply, wastewater, rainwater, gas, heating and communication. Develop integrated pipeline corridors for all new roads and urban areas.
- **Sponge cities**: Build cities using grass trenches, seepage tiles, rain gardens, sunken green space and other green measures to facilitate drainage and improve the city's rainwater use, storage and absorption capacity.
- **"Zero-waste city" policy**: Implement a "zero-waste city" policy[163] (pilot projects have already started in 11 cities and five regions);[164] continue to promote waste reduction at source; practise efficient resource utilization; and build environmental infrastructure in a way that integrates wastewater, garbage, solid waste, hazardous waste and medical waste treatment, disposal, testing and supervision capabilities.

Electricity generated from Foshan Nanhai's solid waste incineration process provides enough power for 400,000 people in 160,000 households

CASE STUDY

Foshan Nanhai solid waste treatment environmental protection industrial park

Covering a total area of 30.7 hectares, Foshan Nanhai solid waste treatment environmental protection industrial park can handle 26 categories of hazardous waste. It boasts a domestic waste incineration power plant with a daily processing capacity of 4,500 tonnes of domestic waste, a sludge drying plant with a daily capacity of 450 tonnes, a kitchen waste treatment plant with a daily capacity of 600 tonnes and a Foshan Green Industry Service Centre project that can handle 93,000 tonnes of industrial hazardous waste every year.

The domestic waste incineration power plant is both an energy centre and a treatment centre. The process of incinerating domestic waste generates a large amount of stable and economical electrical energy, which powers various other projects in the industrial park. The excess heat from incineration steam is used for sludge drying, hazardous waste treatment and kitchen waste oil extraction. This process not only makes full use of excess heat resources, but also reduces the operating costs of sludge, kitchen and hazardous waste treatment projects. The odour generated from the sludge drying and kitchen waste treatment plants is pumped into the domestic waste incineration power plant through a negative pressure system for incineration. The residue left over from kitchen waste treatment and dried sludge does not need to be landfilled, it can be incinerated along with domestic waste. This not only reduces disposal costs, but also leads to power generation benefits. The electricity generated from the park's waste incineration processes provides enough power for about 400,000 people in 160,000 households nearby.

Through resource-sharing and synergies between different waste treatment processes within the industrial park, a complete chain of domestic solid waste treatment from the source to the solution has been formed, leading to 100% bio-safe domestic waste disposal across the whole district of Nanhai. This solid waste treatment industrial park model has been successfully replicated and promoted in a number of other provinces, cities and regions. It has been named the "National Popular Science Base for Ecological Environment".

Source: Technology Communications Today, "Foshan Nanhai Solid Waste Treatment Environmental Protection Industrial Park Stands Out", 18 January 2021, https://www.360kuai.com/pc/9f081e9f3c67b34ff?cota=3&kuai_so=1&sign=360_57c3bbd1&refer_scene=so_1.

Where are we now and where do we need to get to?

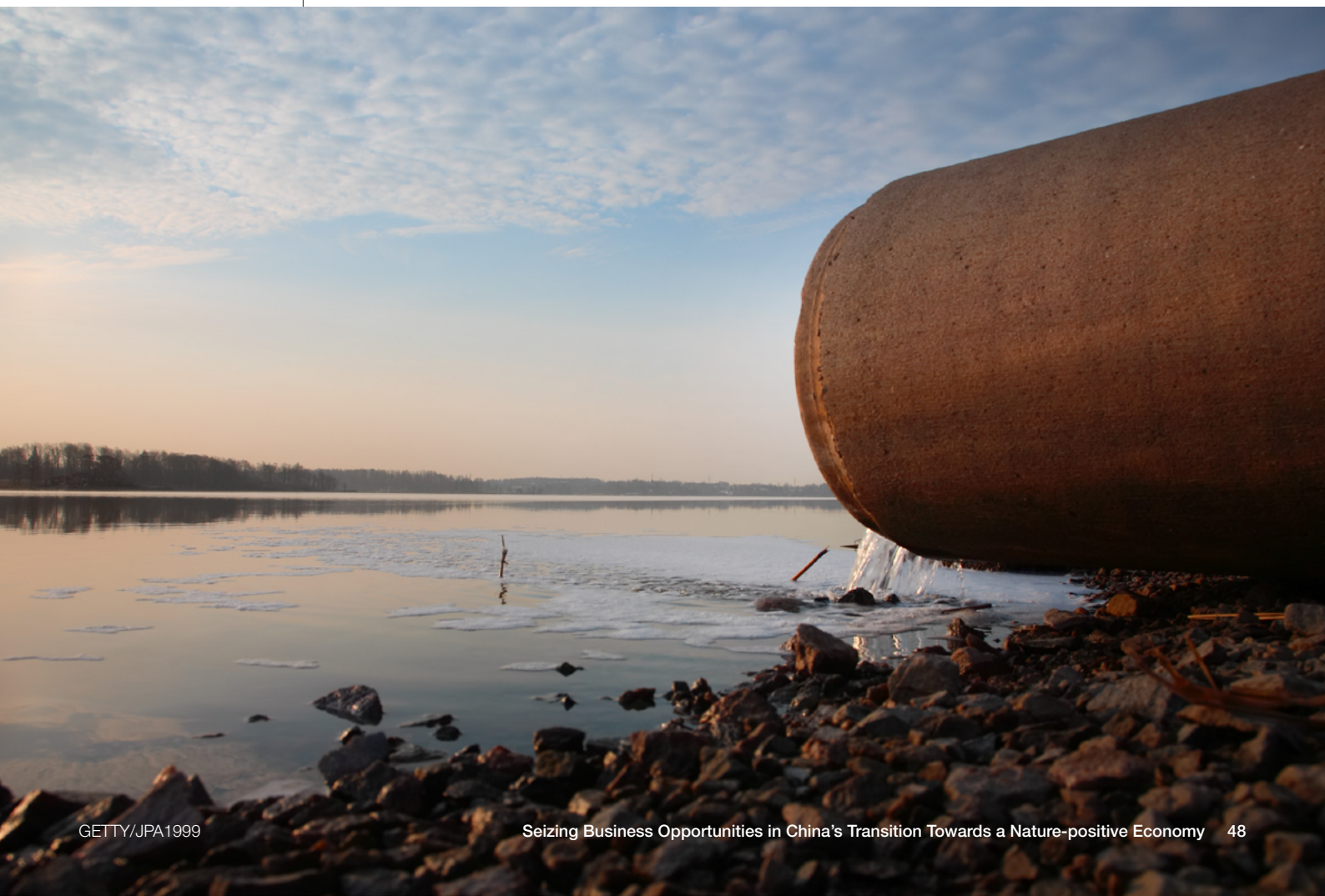
China discards about 10 billion tonnes of solid waste every year and urban solid waste flows are increasing at a rate of about 8% a year. In 2020, China incinerated 62% of its waste and buried 33% in landfill

China discards about 10 billion tonnes of solid waste every year and the accumulated stockpile has now reached 60-70 billion tonnes.[165] Urban solid waste flows are increasing at a rate of about 8% every year.[166] China is still in the preliminary stages of solid waste treatment, incinerating 62% of its waste and burying 33% in landfill in 2020.[167] Due to the low degree of waste sorting and separation, the waste utilization and resource recovery rate remains low. As a result, the private sector lacks incentives to invest in the waste treatment industry due to the intensive capital requirement and long pay-back period, resulting in a vicious circle.

In December 2018, China published the *Zero-Waste City Construction Pilot Work Plan*. In April 2019, 11 cites were identified as pilot zero-waste cities, including: Shenzhen City of Guangdong Province, Baotou City of Inner Mongolia Autonomous Region, Tongling City of Anhui Province, Weihai City of Shandong Province, Chongqing City (main urban area), Shaoxing City of Zhejiang Province, Sanya City of Hainan Province, Xuchang City of Henan Province, Xuzhou City of Jiangsu Province, Panjin City of Liaoning Province, and Xining City of Qinghai Province.[168] With the introduction of a public-private partnership (PPP) model in recent years, private capital funds most of the infrastructure designing, building, operating and maintenance work, while government sectors are responsible for the price and quality supervision of infrastructure and public services.

China needs to continue to improve its waste-sorting facilities and systems in the future, aiming to reach a separation rate of wet waste of over 39%[169] and a harmless disposal rate of urban sludge of 90% by 2035.[170] The government can also encourage the private sector to invest in high-quality waste-to-energy projects or end-to-end solid waste treatment industrial parks, by providing financial incentives such as favourable loan policies and promoting public-private partnerships.

As China's urban water consumption continues to rise, rainwater collection and utilization, wastewater recycling and seawater desalination have become the main measures to develop new urban water sources. Since the construction of the first pilot sponge cities in China in 2015, sponge cities have given full play to the functions of rainwater absorption, infiltration and slow release by buildings, roads, green spaces, water systems and other ecosystems. By the end of 2020, China had built more than 40,000 projects practising the concept of sponge city construction, achieving an annual utilization of rainwater resources of 350 million tonnes.[171] In future, the country will enhance the drainage and flood control capacity of each city, and continue to construct sponge cities and resilient cities, with the aim of eliminating urban waterlogging under rainfall conditions within the flood prevention and control standard.[172]



Sewer pipe and effluent discharge

GETTY/JPA1999

3.5 Nature as infrastructure

What is it?

Surface water and groundwater have been contaminated by wastewater in recent years, resulting in water security issues becoming a major challenge for many countries and regions around the world. Moreover, the cost of building infrastructure to adapt to climate change and withstand extreme weather, such as floods and hurricanes, is constantly increasing. However, the need for man-made engineering solutions may be reduced by restoring or building natural ecosystems, such as wetlands, forests and mangroves, which can not only significantly cut down costs, but also enhance the conservation of biodiversity and promote residents' physical and mental health.

Analysis by The Nature Conservancy (TNC) shows that four-fifths of cities can improve their water quality and reduce sediment and nutrient pollution by more than 10% through restoring and protecting water sources.[173] Nature-based water supply solutions could save the world $21 billion annually by 2030.[174] Nature-based solutions are on average 50% more cost-effective than "grey" alternatives and deliver 28% more added value. Yet they received just 0.3% of overall spending on urban infrastructure in 2021.[175]

Nature-based solutions are on average 50% more cost-effective than "grey" alternatives and deliver 28% more added value. Yet they received just 0.3% of overall spending on urban infrastructure in 2021.

To achieve this transition, countries must first protect and restore their natural ecological infrastructure and insist on the organic integration of the living community of "mountains, rivers, forests, farmlands, lakes, grasslands and deserts" with urban development. Secondly, municipalities should build out urban infrastructure using the principles of "blue, green and grey". The energy consumption of "grey infrastructure" should be reduced, alongside new investments in building "blue and green infrastructure".

For example, wetlands can purify wastewater, store water and supply water; mangroves can protect against wind and waves and reinforce dams. Meanwhile, forests in cities can clean the air, help reduce the urban heat-island effect, form a better microclimate, create habitats for plants and animals, provide shade and shelter for people, and improve residents' physical and mental health.

Where are we now and where do we need to get to?

The rapid urbanization of China has caused serious negative impacts on natural asset such as forests, grassland, farmland, estuaries, coastal landscapes and wetlands, leading to the fragmentation of ecological land and reducing the connectivity between landscapes and cities, thereby weakening the ecosystem service functions of ecological spaces.

In the past five years, the central government has allocated $7.83 billion to launch 25 major mountain-river-forest-farmland-lake-grass integration projects for continuous ecological restoration, resulting in a significant increase in biodiversity.[176] Meanwhile, green zones within urban built-up areas have reached more than 2.3 million hectares, with average green coverage exceeding 40% and per capita green area reaching 14.8 square metres.[177] Between 2000 and 2017, a quarter of the planet's newly added green areas came from China, ranking it first in the world on this initiative.[178] At the same time, the country has implemented a series of effective measures, such as the treatment of black and odorous water bodies, urban renewal, territorial space-use regulation, restoration of natural shorelines, removal of dams and dykes to restore marine ecosystems, defining of ecological conservation red lines, and developing policies and regulations on the protection of wetlands.

To continue this transition into the future, infrastructure planning bodies need to build their capacity and awareness to integrate the nature-as-infrastructure solution into planning for the built environment. It is imperative to encourage private sector investment and participation in the design and management of ecological conservation and restoration projects, as well as to explore ecological industries[179] such as eco-tourism.

CASE STUDY

Haikou wetland ecological restoration

Wetlands are known as the "kidneys of the earth". They are one of the most biodiversity-rich ecosystems in nature. Haikou, in Hainan Province, has a complex system of rivers, marshes, lakes and reservoirs, with a wetland area of 29,093 hectares and a wetland rate of 12.7%. However, due to rapid urban development and environmental pollution, the area of wetlands in Haikou is decreasing year by year and their ecological function continues to degrade.

In 2016, Haikou launched a comprehensive treatment of water bodies to enhance the ecological functions of wetlands, to maintain wetland biodiversity, and to eliminate black odour in water bodies through source control, endogenous treatment, ecological restoration and living water quality. In addition, Haikou developed wetland protection and restoration projects according to local conditions, such as combining wetland restoration with water treatment.

The city built an artificial terraced wetland which can treat 5,000 tonnes of sewage per day, over a 3.5-hectare construction waste dumping site in the Fengxiang section of the Meishe River. It also planted around 23,000 mangrove trees, which is the first successful case of planting mangroves in an inner-city river in China. The Meishe River National Wetland Park now receives up to 4,000 visitors per day.

In 2018, Haikou became one of the first 18 "International Wetland Cities" in the world. When Martha Rojas-Urrego, Secretary General of the UN's Ramsar Convention on Wetlands, visited Haikou, she said that the practice of wetland protection and restoration in Haikou could serve as an example of ecological restoration for cities across the world. Today, the wetland protection rate has reached nearly 53% in Haikou. As the ecological condition of wetlands has improved, the quality of the human living environment has also been significantly enhanced, biodiversity has been restored, and citizens can now view and enjoy wetlands at their doorstep.

Source: State Forestry and Grassland Administration, "Wetland Protection, Haikou: 'Wetland +' into the good life of the public", 23 June 2020, https://m.thepaper.cn/baijiahao_7966059.

3.6 Nature-positive connecting infrastructure

What is it?

Connecting infrastructure such as roads, railways, ports, oil and gas pipelines, and cross-sea bridges may have an adverse effect on the surrounding environment and damage or even destroy fragile ecosystems. Studies have shown that population densities of mammals and birds are lower near such infrastructure, affecting a radius of up to 5 kilometres.[180] Nature-positive connecting infrastructure aims to reduce the overall impact of the connecting infrastructure on the environment and human health, and to promote the synergistic development of transportation and the environment through the construction of ecological transportation networks.

When building connecting infrastructure, authorities should prioritize nature-positive measures in the following five areas:

- **Site selection:** Optimize traffic routes and site selection; establish a transportation network coordinated with the ecological conservation red line and natural protected areas; adapt to the carrying capacity of the local environment; make full use of traffic corridor resources; and reduce land occupation and ecological division.
- **Construction:** Promote and develop "zero-harm" standards for infrastructure crossing ecologically sensitive areas. This should involve building animal passages according to local conditions, minimizing the impacts from manmade projects and creating a "close-to-nature" environment. For waterway connecting facilities, authorities should promote the construction of ecological revetments; restore the bottom-dwelling environment; strengthen the conservation and release of marine species; and build migration channels to protect natural habitats as much as possible.
- **Materials:** Use environmentally friendly, durable and energy-saving materials in the construction of connecting infrastructure to reduce whole-life resources and energy consumption.[181]
- **Energy:** Promote renewable and clean energy; apply new technologies such as 5G to build connections between vehicles, traffic information and road management systems; promote multimodal transport; and digitalize the transport sector.
- **Financing:** Provide sustained infrastructure funding; including securitization financing for infrastructure; and encourage private capital by optimizing the investment environment and improving the financial market framework.

Where are we now and where do we need to get to?

Guided by the ecological civilization concept, China has continued to develop green transportation and green connecting infrastructure. In 2017, the Ministry of Transportation issued its *Views on the Comprehensive and In-depth Promotion of Green Transportation Development,* which set a series of goals by 2020, such as building green transportation infrastructure demonstration projects and implementing transportation infrastructure ecological restoration projects, as well as more effectively controlling pollution emissions (including carbon dioxide) from transportation and infrastructure such as ports.[182]

By the end of 2020, China had implemented ecological restoration on 50 million square metres of roads and ports, rectified 1,361 illegal docks and further regulated sand mining along the Yangtze River, which has improved the river's ecological and environmental conditions.[183] Railway transport also grew significantly. The increased passenger turnover on high-speed trains from 2012 to 2019 reduced CO_2 emissions by 23.2 million tonnes compared to the same trips if done by car.[184]

China is also investing in scientific research and developing digital and lightweight transportation facilities that use renewable energy. The application of the BeiDou Navigation Satellite System, 5G, the internet of things and other technologies can enable end-to-end information management and improve traffic efficiency, thus reducing traffic costs and cutting down pollution and carbon emissions.[185]

In terms of governance, China is committed to improve the policy consultation mechanism between transportation and territorial spatial development, urban and rural development, and ecological and environmental conservation, while promoting the integration of multiple regulations and improving policy unity, rule consistency and implementation synergy.

In addition, financial institutions and investors have a responsibility to carry out the necessary due diligence to ensure that they can finance sustainable projects. Over 40 institutions have signed the *Green Investment Principles (GIP) for the Belt and Road Development* since 2018, with total assets under management of the signatories reaching $49 trillion.[186] By the end of 2020, 15 GIP members had made their environmental disclosures, in line with the Taskforce on Climate-related Financial Disclosures (TCFD). It is expected that all GIP members will disclose environmental information by 2023.[187] These green investment principles, which are based on existing responsible investment initiatives, integrate low-carbon and sustainable development priorities into projects in countries along the Belt and Road, and help investors to direct capital towards environmental, social and governance-related investments under the Belt and Road framework, according to objective evaluation criteria.

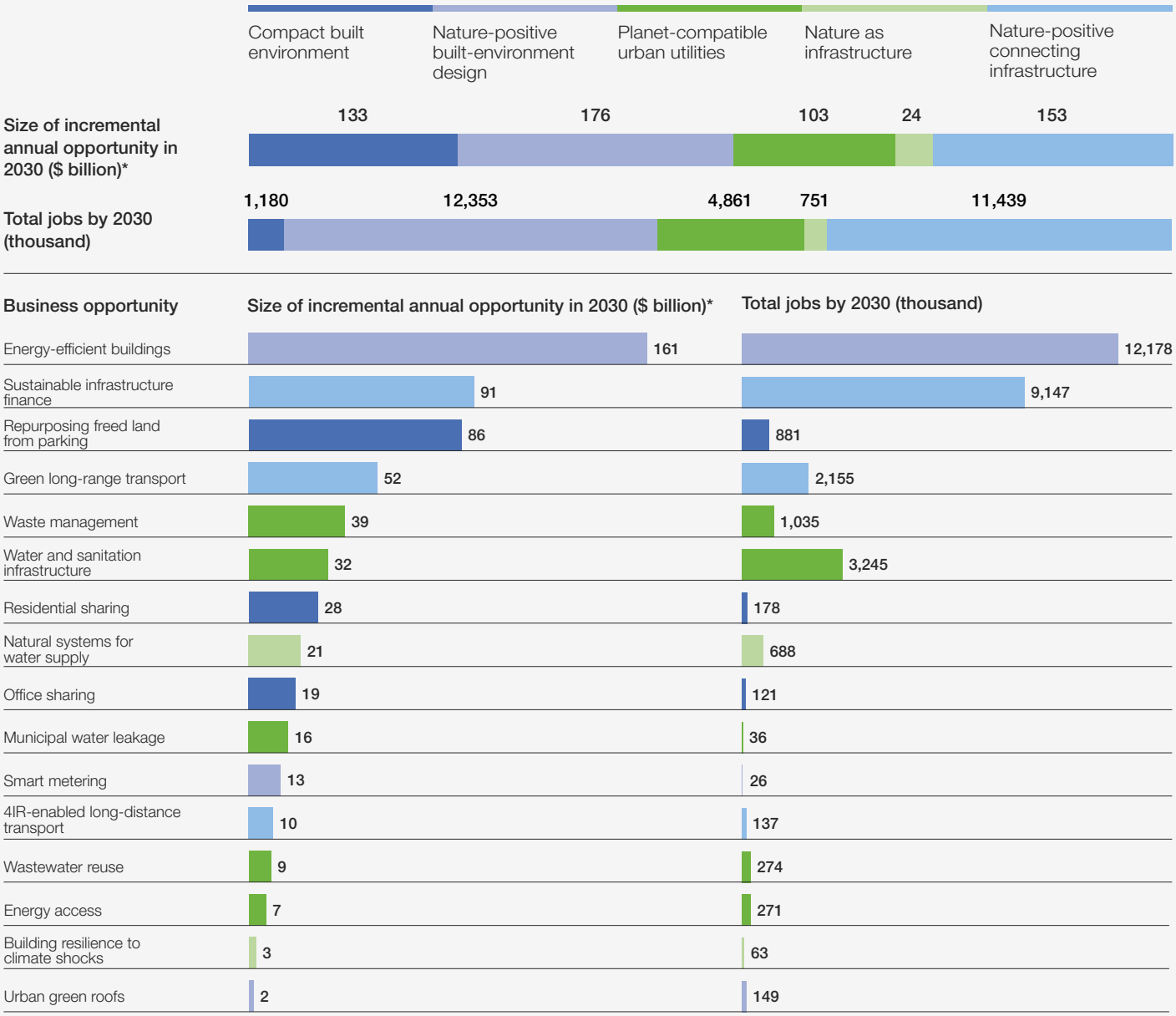
Aerial view of Hong Kong–Zhuhai–Macau Bridge, China

GETTY/COCOSAN

3.7 Future business opportunities

By 2030, the five transitions described above will boost the nature-positive development of China's infrastructure and built-environment system. The new business opportunities emerging in this process are expected to create $590 billion in business value and 30 million new jobs.[188] These business opportunities mainly exist in the fields of energy-efficient buildings, sustainable infrastructure financing, remodelling of parking-lot land use and green long-distance transportation. These opportunities are analysed in greater detail below.

FIGURE 11: **Business and job opportunities arising from the transition to nature-positive infrastructure and the built environment**



* Based on estimated savings or project market sizing in each area. These represent revenue opportunities that are incremental to business-as-usual scenarios. Where available, the range is estimated based on analysis of multiple sources. Rounded to nearest $ billion.

Sources: Food and Land Use Coalition (FOLU); Business and Sustainable Development Commission (BSDC); The Nature Conservancy (TNC); World Resources Institute (WRI); McKinsey Global Institute (MGI); market research; literature review; AlphaBeta analysis.

The five transitions proposed for China's infrastructure and built-environment system are expected to create $590 billion of annual business value and provide 30 million new jobs by 2030

Energy-efficient buildings

By the end of 2018, the cumulative green building area in urban construction nationwide exceeded 2.5 billion square metres, with green structures accounting for more than 40% of new urban buildings.[189] In 2019, China issued the *General Plan of Green Life Creation Action*, which proposed a goal of 60% green buildings in new urban areas by 2022 and put forward green creation requirements for schools and government organizations.[190]

Remodelling parking-lot land use

This opportunity refers to reducing parking areas through technological innovation, rational planning and business model innovation, while the land freed up will create great commercial value. In 2019, the ratio of vehicle-owner households to parking spaces in China was between 1:0.5 and 1:0.8, which is very low compared to the international ratio of 1:1.3. The total shortfall in parking spaces was more than 50 million. At the end of 2020, China's mechanical parking spaces (stacking vehicles vertically to save space) reached 7,566,200.[191] Mechanical parking garages are playing an increasingly important role in relieving urban traffic congestion and parking difficulties.

Encouraged by the government, the smart parking industry has developed rapidly. The smart parking market was worth $94 billion in 2020 but it is expected to grow to around $219 billion by 2025.[192]

In addition, shared transportation (e.g. public transport, shared travel, carpooling etc.) can free up parking spaces. China's shared transportation system is an innovative travel model born from the overlap between traditional travel demands and new technologies such as big data and mobile internet, creating a market size of nearly $35 billion in 2020.

Green long-distance transportation

Today, the vast majority of long-distance trucks are powered by internal combustion engines, entailing enormous fuel consumption and pollution emissions. New energy technology has developed rapidly in recent years, but it has not made great progress in long-distance highway transportation. The main reasons are as follows:

- The power capacity of existing batteries is not sufficient to service long-distance heavy trucking transportation
- Boosting the power capacity of truck batteries would increase the dead weight of the tractor-unit so much that the industry would become financially unviable
- The long charging time of truck batteries, often midway through a journey, hampers transportation efficiency
- Battery replacement technology is complicated and cannot be widely popularized and applied

The consequence of these challenges is to create a business opportunity to build an efficient, compatible and well laid-out charging service network for electric trucks. The Ministry of Transport has issued its *14th Five-Year Plan for Comprehensive Transport Services*, which sets goals for China to actively promote the development of new-energy and clean-energy vehicles and ships, to increase policy support towards the operation of clean transportation (e.g. access, parking, charging etc.), and to accelerate the planning and construction of electrical and hydrogen-based charging infrastructure. In the meantime, China will actively combat pollution from diesel trucks by encouraging local governments to restrict their use through enforcing the phase-out of high-emissions vehicles.

4 Nature-positive energy and extractives system

Renewable solar power panel against the Shanghai Bund skyline

GETTY/JEFF_HU

The increase in China's energy consumption accounted for three-quarters[193] of global energy growth in 2019, while energy consumption per unit of GDP was 50% higher than the world average.[194] In the effort to reduce carbon emissions and develop renewable energy sources, the risk that the deployment of energy-generation facilities might encroach on, fragment, pollute or disturb animal habitats needs to be taken into consideration. In addition, the production of wind energy, photovoltaic panels and other new energy-supporting power storage facilities could lead to a significant increase in demand for certain metals. For example, demand for the nickel used in lithium batteries is expected to increase 16-fold to 1.8 million tonnes by 2030.[195]

Among China's 97 national economy industry categories, 20 are closely related to the energy and extractives system (see Figure 12).

4.1 Four priority transitions – a summary

To curtail the negative impacts of China's energy and extractives system on nature, a radical change in the current development model is needed to promote a transition towards a nature-positive model. Four priority transitions are summarized in this section below and each is addressed in greater detail in subsequent sections of this chapter:

1. Circular and resource-efficient models for materials
2. Nature-positive metals and minerals extraction
3. Sustainable materials supply chains
4. Nature-positive energy transition

1. Circular and resource-efficient models for materials

The first transition is to redesign products, services and production systems in a circular and efficient way to maximize resource cost-savings and reduce energy consumption. In China, this transition towards a circular economy embraces a wide range of applications, including for example vehicle lifecycle management, power-battery cyclical utilization, construction-waste recycling, renovation and remanufacturing of waste electrical and electronic items, and express packaging and recycling of plastic products. Although many enterprises are still in a trial stage, breakthroughs can be made through greater investment, developing market opportunities and creating profit models.

2. Nature-positive metals and minerals extraction

The second transition is to minimize land damage from the energy and extraction system and compensate for the impact on biodiversity of mineral resource-extraction processes that cannot be avoided or mitigated. This transition considers the nature-positive potential of the full lifecycle of extraction, based on the principle of "avoiding, reducing, repairing and compensating". The Ministry of Natural Resources released the *National Green Mine Construction Code* in 2018, which clarifies the social responsibility of mining enterprises for environmental protection and governance in the development and utilization of their mines.[196]

In China, the degree of mechanized extraction of mineral resources exceeds 80%, which is still lower than in other mining countries, some of which are 95%-100% mechanized.[197] An increase in mechanization would improve the efficiency of mineral extraction and processing.[198] Mining companies should build responsible procurement supply chains and use scientific mining methods with new technologies, to minimize ecological damage and implement systematic ecological restoration. Moreover, organizations and large enterprises within the industry can provide the necessary knowledge and skills training for owners of small and medium-sized metal mines and other mines.

FIGURE 12: **Four transitions and 19 industries within the energy and extractives system**

Sector role in transition: Principal / Enabling

Sector	Transition: Circular and resource-efficient models for materials	Nature-positive metals and minerals extraction	Sustainable materials supply chains	Nature-positive energy transition
Coal mining and washing	Enabling	Principal	Enabling	Enabling
Ferrous metal mining and dressing	Enabling	Principal	Enabling	Enabling
Non-ferrous mining and dressing	Enabling	Principal	Enabling	Enabling
Non-metallic mining and dressing	Enabling	Principal	Enabling	Enabling
Mining and auxiliary activities	Enabling	Principal	Enabling	Enabling
Other mining	Enabling	Principal	Enabling	Enabling
Non-metallic mineral products	Principal	Enabling	Principal	Enabling
Ferrous metal smelting and rolling processing	Principal	Enabling	Principal	Enabling
Non-ferrous metal smelting and rolling processing	Principal	Enabling	Principal	Enabling
Metal products	Principal	Enabling	Principal	Enabling
Metal products, machinery and equipment repair	Enabling	Enabling	Enabling	Enabling
Oil and gas extraction	Enabling	Principal	Enabling	Enabling
Oil, coal and other fuel processing industries	Enabling	Enabling	Enabling	Enabling
Culture and education, arts and crafts, sports and entertainment goods manufacturing	Principal	Enabling	Enabling	Enabling
Automotive manufacturing	Principal	Enabling	Enabling	Principal
Computer, communications and other electronic equipment manufacturing	Principal	Enabling	Enabling	Enabling
Electricity, heat production and supply	Enabling	Enabling	Enabling	Principal
Gas production and supply	Enabling	Enabling	Enabling	Principal
Water conservancy management	Enabling	Enabling	Enabling	Principal

Sources: Industrial classification for national economic activities (GB/T 4754—2017), World Economic Forum, GoldenBee analysis.

3. Sustainable materials supply chains

> China's wind and solar power generation accounted for 30% of the world's total in 2020, and the installed capacity of solar and wind power is expected to double to more than 1.2 billion kilowatts by 2030

The third transition is to build sustainable materials supply chains to ensure the transparent and traceable procurement of materials. China's overseas investments in mining projects have been growing rapidly, especially in Africa. The mining industry accounted for 24.8% of all Chinese investment in Africa in 2020.[199] Transparent supply chains will help to reduce the social and environmental impacts of mineral management conflicts, illegal extraction and the non-compliance of suppliers.

The government has compiled the *Chinese Due Diligence Guidelines for Responsible Mineral Supply Chains* and plans to build more sustainable material supply chains in the future through various protection initiatives, mining and material industry governance frameworks, company commitments and responsibilities, as well as through the technological innovations offered by the Fourth Industrial Revolution. For example, the use of blockchain technology in supply-chain management can ensure more transparent information flows between upstream and downstream enterprises, improve the effectiveness of monitoring and auditing processes, help solve product traceability and transaction disputes, and reduce communication costs at the same time.

4. Nature-positive energy transition

China has set ambitious "dual carbon goals" to peak carbon dioxide emissions before 2030 and to achieve carbon neutrality by 2060. Intensive investment in solar and wind power, along with energy storage systems, will be required to meet China's energy demands during this transition. Fossil fuel extraction impacts biodiversity directly through disrupting natural habitats, while the burning of fossil fuels significantly contributes to climate change and its impacts in turn threaten biodiversity. China's leaders are in no doubt that the country has to transition away from fossil fuels towards cleaner energy sources – the question is how.

China's wind and solar power generation accounted for 30% of the world's total in 2020, and the installed capacity of solar and wind power is expected to double to more than 1.2 billion kilowatts by 2030.[200] To ensure such an ambitious transition does not come at the expense of nature, the transition requires a thoughtful approach to avoid any unintended consequences, for example through a heavy reliance on rare-earth minerals for batteries or the disruption of land- and ocean-based ecosystems through the installation of wind and solar farms. The adoption of natural climate solutions should balance the climate benefits brought by new energy (e.g. biomass) with its impact on nature.

Wind turbines in the sunset in Fujian Province

GETTY/CHINAFACE

4.2 Circular and resource-efficient models for materials

What is it?

The conservation-orientated circular production model aims to redesign the way that products, services and systems are created, thereby maximizing resource cost savings and reducing energy consumption. To achieve the transition towards a circular production model, the design process needs to incorporate repair, refurbishment and remanufacturing processes from the outset, in order to promote the reuse and shared use of resources.

Many enterprises within the energy and extractive industries could benefit from a conservation-orientated and circular production mode, whether they are engaged in, for example, vehicle lifecycle-management, power-battery cyclical utilization, construction-waste recycling, renovation and remanufacturing of waste electrical and electronic items, recycling of express packaging and plastic products, or the comprehensive utilization of bulk solid waste. China leads the world in volumes of car ownership and auto-production. Recycling and remanufacturing auto parts, especially the electronics, plastics and other materials needed for electric vehicles,[201] will play a key part in the transition to the circular economy.

The recycling of construction materials is another priority. Waste can be reused, for example scrapped bricks, wood, concrete and metal. Innovations are possible in building materials and construction methods. For example, the "blocks-building" container modular process can save on building materials and promote better recycling of stainless steel and scrap steel without weakening the use function. A third initiative to consider is the additive manufacturing technique (also known as 3D printing) – a "bottom-up" manufacturing method that can save money and resources by reducing the use of materials that traditional material removal and cutting techniques incur.[202]

CASE STUDY

Advancing automobile reuse through a circular model for car and battery materials

With the development of the electric vehicle industry, the demand for batteries continues to rise. As a result, the production, disposal and recycling of batteries has become a major concern for green development. Through recycling waste batteries, the recovered nickel, cobalt, manganese, lithium and other metals can ensure an ongoing supply of raw materials for manufacturers. In 2018, the Ministry of Industry and Information Technology proposed that automobile manufacturers should take responsibility for the process of recycling waste power batteries from end-of-life electric vehicles.

Geely Auto, one of China's major independent automobile brands, has funded a joint venture dedicated to maximizing resource utilization from waste lithium batteries. Its new-energy power batteries can be recycled for cascaded utilization, for example in the energy storage systems planned by Geely for its photovoltaic power generation projects. Besides battery recycling, Geely attaches great importance to the environmental performance of automotive products from all aspects of its cars' entire lifecycles. For example, the company tracks and restricts non-recyclable materials such as asphalt boards and damping concrete boards. In 2019, the average recycling rate of materials from end-of-life cars was 96.8%.

Geely's battery recycling and manufacturing model presents a good example for the green manufacturing of electric vehicle batteries in China and other countries. As China takes a leading role in the global electric vehicle industry, the recycling of car batteries and other auto-resources can create considerable new business opportunities.

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Where are we now and where do we need to get to?

> If the construction industry were to use advanced building technologies including the reuse and recycling of demolition waste, Chinese cities could reduce their consumption of raw materials by 71% by 2040

During the 13th Five-Year plan period (2016-2020), China's principal resource productivity increased by about 26%. Comprehensive utilization rates (conversion of waste into usable resources)[203] reached 50% for construction waste and 55% for bulk solid waste – 5% higher than in 2015.[204] However, China's renewable resources recycling rate is still lower than that of Germany, Japan and other countries with high levels of recycling.[205] The traditional model of "mass production, mass consumption, mass waste" has not yet been fundamentally reversed, so it is urgent to develop a sustainable business model.[206]

China's *14th Five-Year Plan for the Development of the Circular Economy* proposes that the country will establish an industrial resource recycling system by 2025,[207] to provide the basis for the development of this transformation. Two of the three key tasks proposed in the plan are:

1. Improve the efficiency of resource utilization through the development of the circular economy

2. Develop the recycling of waste materials, particularly those in the automobile manufacturing industry

The number of cars in China reached 290 million in 2020, while the number of recycled old cars reached just over 2 million,[208] accounting for just 0.75% of car ownership.[209] This proportion lags well behind the 5% vehicle-recycling rate of developed countries. Additive manufacturing (3D-printing) technology has been developing rapidly in recent years and could help in the transition to a circular economy because of its wide production flexibility and high material utilization.[210] According to *Global and Chinese 3D Printing Industry Data in 2019*, China's 3D-printing industry sales topped $2.46 billion, an increase of 31% from 2018.[211]

Other related industries are also trying to shift towards more circular models. As a major producer and consumer of steel, during the 13th Five-Year Plan China's steelmakers made use of 874 million tonnes of scrap steel, saving 306 billion kg of standard coal and reducing solid waste emissions by 2.6 billion tonnes, compared to making new steel using iron ore.[212]

To continue to develop a conservation-orientated and circular production model in China requires the full commitment of China's major industries and industrial regions. If the construction industry, for example, were to use advanced building technologies across their portfolios, including the reuse and recycling of demolition waste, Chinese cities could reduce their consumption of raw materials by 71% by 2040.[213] It is equally important to build a resilient circular economic system to withstand resource price-rises. This in turn requires strong regulatory and financing mechanisms to drive the industry's transition towards a circular production model.

3D printing technology

GETTY/KYNNY

4.3 Nature-positive metals and minerals extraction

What is it?

The traditional extractive industry has a major negative impact on the ecological environment. For example, long-term underground mining may lead to geological disasters such as landslides, while oxidization and wind erosion of waste ore piles and tailings ponds may lead to the leaching of hazardous substances into surface water bodies, cropland and lakes. The nature-positive metals and minerals extraction transition aims to reduce destructive land-management methods, enhance ecological conservation and restoration, and offset unavoidable biodiversity impacts.

Authorities should ensure the following priorities are adhered to by entities extracting metals and minerals:

- Carry out rational land-use planning, commission biodiversity assessments and reduce the impact of auxiliary infrastructure such as roads and power lines on the ecosystem.
- During the mining process, land damage should be minimized through, for example, improving the extraction operation's efficiency with mechanization measures, avoiding the use of highly toxic chemicals such as mercury, nitric acid or lead explosives, and reducing water consumption.
- After the available metal and mineral reserves have been completely mined, systematic ecosystem restoration must be implemented within and around the mining site.
- Owners of small and medium-sized metal mines and other mines should be provided with the necessary knowledge, training and funding to assist in their capacity building.
- Consult and engage with local communities and respect indigenous land rights.

Where the environmental impact is hard to avoid, biodiversity offset activities, either onsite or offsite, should be carried out. By leveraging the mitigation hierarchy framework of the UN's Convention on Biological Diversity, the impacts of metal and mineral extraction on nature can be avoided, minimized, remediated and offset.

According to the *U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s*, China will phase down coal consumption during the 15th Five Year Plan period (2026-2030) and make best efforts to accelerate this work. From 2015 to 2020, China reduced the proportion of coal in primary energy consumption from 64% to 61%. To achieve China's targets to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060, it is crucial to reduce the demand for and the consumption of coal resources, restore the ecosystem functions of mining areas, and increase the share of renewable energy to speed up China's transition to clean energy in the next 10 years.

CASE STUDY

Restoration of mining areas in Inner Mongolia integrates solar power with farming

By the end of 2020, China Energy had a total installed power capacity of 257 gigawatts, of which 46 gigawatts was wind power, ranking first in the world. To achieve a peak in carbon emissions by 2030, China Energy has developed a new five-year strategy, aimed at increasing the share of installed energy capacity not based on fossil fuels to 40% by 2025.

The corporation explored technologies and digital solutions to improve resource efficiency while reduce energy consumption and emissions. In 2020, its energy consumption per unit (10,000 yuan) output value decreased by 13.4% compared to 2018 and 36 of its coal mines are listed as China's national green mines. It has developed new ways of combining ecological restoration of mining areas with photovoltaic power generation.

For example, Zhungeer Mining Area, located on the Ordos Plateau in the south of Inner Mongolia, is an area suffering some of the most serious soil erosion in China, with sparse vegetation and a fragile ecosystem. To address the issue, China Energy's key opencut mining subsidiary, Zhungeer Energy Group Co., Ltd. (Zhungeer Energy) created an integrated soil erosion-control technology system and implemented a soil and water conservation project in mining areas. The aim of the project was to realize the related goals of green mining, reclamation and restoration, along with the coordinated development of modern agriculture, animal husbandry and mining.

Zhungeer Energy also carried out a special study on vegetation restoration and ecological management in the Loess Plateau, screened out nearly 100 kinds of plants suitable for planting and established four scientifically sourced new varieties (shrub-grass, arbour-grass, arbour-shrub and arbour-shrub-grass types), while achieving a diversity of species and ecosystems in mining areas.

Through the principle of conservation while mining, the company has been able to conserve more than

3,300 hectares in Zhungeer Mining Area, improving vegetation coverage from 25% to 80%, planting 69 million trees and shrubs attaining a soil erosion-control rate of over 80%. Of the 3,300 hectares of restored land, 860 hectares have been dedicated to innovative solutions such as agriculture/husbandry-solar hybrid projects. This involves the installation of solar power generation on land that is also used for agricultural planting and animal husbandry, enabling the multiple utilization of land resources.

The value of such ecosystem regulation services in mining areas in 2020 increased by $139 million compared to 2016. As the world moves to phase down coal, energy companies should not forget their responsibilities to restore the ecology of mining areas.

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Where are we now and where do we need to get to?

China is one of the largest countries in the world in terms of the extraction and use of mineral resources. While these resources support rapid economic and social development, their extraction brings enormous pressure to the ecological environment. At present, there are more than 120,000 mines in the country. The mining industry, which represents about 5% of China's GDP, is important to the national economy. In China, the degree of mechanized extraction of mineral resources exceeds 80%, but this remains lower than the level in other advanced economies (95%-100%).[214] The average recovery rate[215] of coal-mining areas in China is 83%,[216] as of the end of 2020.

As China's demand for resources continues to rise – and is expected to double by 2060 – the government should place an emphasis on the following measures to achieve a more rapid transition in the extractive industry towards nature-positive methods:

- Upgrade existing mines and impose strict control of permits for new mines
- Implement regulations on destructive mining methods and polluting raw materials
- Prohibit the use of cyanide, sulphuric acid and mercury
- Provide subsidies towards the transition and encourage the R&D of sustainable mining chemicals

Meanwhile, academics should be encouraged to develop technologies and products relevant to sustainable mining, while industry organizations should strongly support capacity- and awareness-building in the field of artisanal and small-scale mining.

For their part, regulators should strengthen the supervision and management of the extractive industry, and implement regulations on the ecological conservation and restoration of mine environments, including extracting deposits from companies and establishing funds to finance such restoration initiatives.

4.4 Sustainable materials supply chains

What is it?

Illegal mining is the second-most lucrative natural resource crime after illegal logging. Many mining booms, particularly in rare-earth minerals, occur in biodiversity hotspots (such as the Democratic Republic of the Congo), but face poor governance and corruption, as well as a high risk of conflict. However, due to complex global supply chains, many extraction industries still struggle to systematically understand the legality of upstream activities in their supply chains. The transition to sustainable materials supply chains aims to avoid the social and environmental risks caused by illegal extraction and supplier non-compliance through building a market for transparent and traceable materials.

To achieve sustainable materials supply chains, China has adopted new digital technologies to improve the transparency of material flows, developed traceability standards and used a systematic approach to track upstream activities in supply chains to address illegal extractions. The government and regulators are also guiding the operations of artisanal and small-scale miners (ASMs), as they are important players in sustainable materials supply chains.

Where are we now and where do we need to get to?

China is highly dependent on foreign countries in the global mineral supply chain, particularly for chromium, lithium and potassium which are extremely hard to source.[217] For example, high-end lithium products required for battery-grade lithium carbonate are in short supply and need to be imported in large quantities. In recent years, China's overseas investment in mining projects has been increasing. According to the *Report on Development of China's Outward Investment and Economic Cooperation 2020*, the mining industry has become an important area of China's foreign investment cooperation.

The overall growth of the mining sector is relatively stable, especially in Africa, where the mining industry accounted for 24.8% of China's total investment in the continent during 2020, an increase of 2.1% over the previous year.[218] Mineral resource extraction and trade are critical to the economic, social and environmental development of African countries over the next three decades. Countries at the starting point of the extractive industry supply chain usually have weak governance capacity. Consequently, it is crucial for governments to frame and implement the right policies and for leading mining companies to standardize their operations and supply chain management. Chinese companies "going global" can play an important role in this regard.

China's Chamber of Commerce of Metals, Minerals & Chemicals Importers & Exporters (CCCMC) has compiled the *Chinese Due Diligence Guidelines for Responsible Mineral Supply Chains*, which can identify, reduce and prevent risks that may fuel conflicts, violate human rights and cause serious impacts, while providing a guarantee mechanism and toolkit for enterprises to implement due diligence.[219] In terms of advanced technologies, China has not adopted a large number of blockchain technologies in the mining supply chain yet. The market value of blockchain in the supply chain is expected to grow rapidly from $9 million in 2017 to $10 billion in 2025, with a compound annual growth rate of over 80%.[220]

4.5 Nature-positive energy transition

What is it?

To reduce China's dependence on fossil energy and enable it to reach its targets to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060, China must plan the large-scale deployment of clean energy technologies and infrastructure, while ensuring that any exploitation of the metals and materials needed for clean energy development does not damage the country's ecosystems.

First, the site selection and design of renewable energy projects is critical to maintaining the health of ecosystems. For example, offshore wind projects can risk blocking migratory paths for birds and fish, leading to fragmentation of marine ecosystems. While deploying offshore power generation facilities, biodiversity protection needs to be considered comprehensively.

Studies show that two-thirds of China's Exclusive Economic Zone offers strong potential for offshore wind power development, but it is also an area of significance for global biodiversity conservation.[221]

Second, minerals and metals such as chromium, lithium and potassium are key elements of renewable energy technologies. Targets to decarbonize China's energy sector will inevitably stimulate the demand for these minerals and metals, which may lead to biodiversity loss, social conflicts and inequality in areas with proven production, such as the eastern lowlands of the Democratic Republic of the Congo. Equally, the collection, repair, recycling and reselling of key metals used in renewable energy projects will bring huge business opportunities.

CASE STUDY

Clean energy production and ecological restoration in wind farm construction

Wind power is a major component of the clean energy transition. While creating the Modou Mountain Wind Farm in Yunnan Province, China General Nuclear Power Corporation (CGN) sought to mitigate some of the ecological damage to the environment that the project threatened to cause. The 18.2 km^2 wind farm has a total of 48MW installed capacity, consisting of 24 two-megawatt windmills. CGN established a biodiversity management system for wind power enterprises based on natural capital assessment. The corporation used this system to implement a number of practical environmental mitigation measures during the processes of construction and operation.

For example, the construction of Modou Mountain Wind Farm resulted in damage to the plant and tree life of the local environment. To restore this ecosystem, CGN paid a forest restoration fee to the government, covered the treatment costs for restoring land temporarily occupied by the construction process (e.g. waste dumps, road slopes, wind turbine hoisting platforms), restored topsoil and replanted the indigenous vegetation. To reduce soil erosion, CGN and other wind power companies have built retaining walls and drainage facilities.

The Modou Mountain Wind Farm took full account of the potential impact of turbine blades on birds. The project conducted assessments on bird species and habitat protection at the site-selection stage of the project, designed the installation to avoid the migration paths of migratory birds, and has carried out long-term biological monitoring and related rescue work during the project operation period.

Analysis using the natural capital assessment methodology has found that the clean energy power generated by Modou Mountain Wind Farm can cut carbon dioxide emissions by nearly 364,600 tonnes, creating a net benefit of $46 million for society and generating a social benefit from vegetation greening of $177,000.

Source: China General Nuclear Power Corporation (CGN), "CGN Annual Report on Biodiversity Protection 2021"

Where are we now and where do we need to get to?

It is imperative for China to build a clean, low-carbon, safe and efficient energy system, while simultaneously ensuring the security of energy supply, meeting the requirements of growing energy demand from society and industry, and balancing these needs with the conservation and restoration of ecosystems.[222]

By 2030, China's projected solar photovoltaic capacity will increase from 250 GW today to 890 GW and wind power capacity will increase from 280 GW to 740 GW

China has already succeeded in building the world's largest clean energy system.[223] Hydropower accounts for 40% of the country's total installed capacity of renewable energy, while China is a global leader in wind and solar power development. Driven by the strategic targets to peak carbon dioxide emissions and achieve carbon neutrality, a new round of investment in China's clean energy industry has been included in the *14th Five-Year Plan (2021-2025)*. By 2030, China is expected to account for 40% of global hydro-electric growth (approximately 610 gigawatts),[224] while solar photovoltaic capacity is projected to increase from 250 gigawatts today to 890 gigawatts, and the installed capacity of wind power will increase from 280 gigawatts to 740 gigawatts.[225]

Energy infrastructure has a long lifespan, so decisions surrounding China's transition to low-carbon energy will affect the health of natural ecosystems for decades. Studies show that dams inflict extremely negative impacts on river basins and ecosystems. At present, only one-third of the world's rivers maintain their natural water flows.[226] Meanwhile, research shows that global production of some key metals would need to increase 12-fold by 2050 if all signatories to the Paris Agreement were to meet their commitments to decarbonize their economies.[227]

The impact of clean energy projects on the ecological environment should be fully considered during site selection. Nature-positive energy transition technologies should be employed, such as low-speed wind turbines, eco-friendly wind power construction and operation, and radar monitoring of bird activities. Solar and wind power companies should be required to strengthen the protection of their local environments and invest in ecological restoration, conservation and release of marine species near offshore wind farms. In appropriate cases, innovative solutions such combining photovoltaic power generation with agricultural planting and livestock farming should be popularized. Moreover, the recycling ratio of special materials and rare-earth materials needed in energy transitions should be improved.

Renewable solar power panel in Fujian province

GETTY/CHUYU

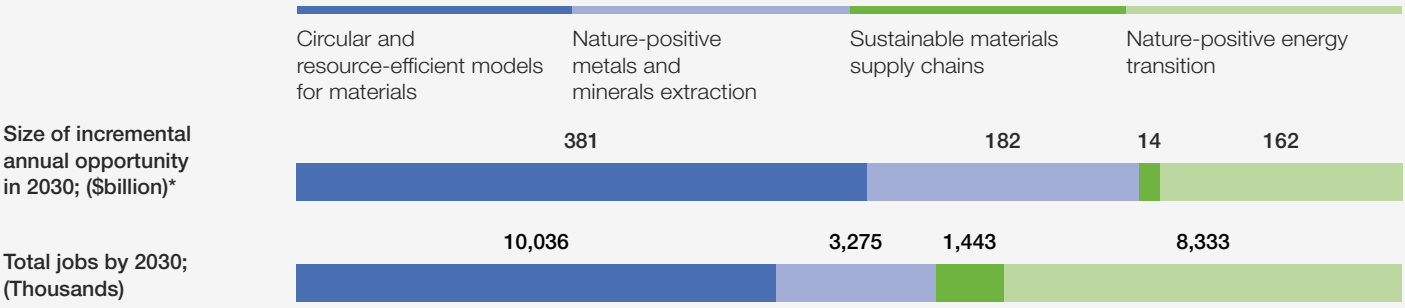
4.6 Future business opportunities

The four transitions detailed above will support the nature-positive development of the energy and extractives system in China. The system is expected to create more than $740 billion of business value and provide 23 million new jobs by 2030 (see Figure 13).[228]

Some of the key business opportunities are detailed below – including the expansion of renewables, circular models in the automotive industry, resource recovery and end-use steel efficiency.

The four transitions proposed for China's energy and extractives system are expected to create more than $740 billion in annual business value and provide 23 million new jobs by 2030

FIGURE 13: **Business opportunities and jobs created by the transition of the energy and extractives system**



Business opportunity	Size of incremental annual opportunity in 2030; ($billion)*	Total jobs by 2030; (Thousands)
Renewables expansion	157	7,867
Circular models – automotive	122	3,788
Resource recovery	118	322
End-use steel efficiency	87	933
Circular models – appliances	79	2,462
Circular models – electronics	55	1,704
Water efficiency in mining	34	878
Additive manufacturing	19	558
Mine rehabilitation	16	1,619
Technology in energy and mining supply chains	14	1,443
Sustainable substances in extraction	10	59
Circular models – plastics	10	296
Circular models – construction	9	295
Redesign of dams	5	466
Shared infrastructure	4	387

* Based on estimated savings or project market sizing in each area. These represent revenue opportunities that are incremental to business-as-usual scenarios. Where available, the range is estimated based on analysis of multiple sources. Rounded to nearest US$ billion.

Sources: Food and Land Use Coalition (FOLU); Business and Sustainable Development Commission (BSDC); The Nature Conservancy (TNC); World Resources Institute (WRI); McKinsey Global Institute (MGI); market research; literature review; AlphaBeta analysis.

Expansion of renewables

> In 2020, China's clean energy accounted for 23.4% of the country's total energy consumption, while the cumulative installed capacity of its hydropower, wind power and solar power generation ranked first in the world

Expanding the scale of renewable energy is the biggest business opportunity to promote the nature-positive energy transition. Renewables are expected to create $157 billion of commercial value and over 7.8 million jobs by 2030. In 2020, China's clean energy accounted for 23.4% of the country's total energy consumption, while the cumulative installed capacity of its hydropower, wind power and solar power generation ranked first in the world.[229]

In September 2021, China issued the *Opinions on Fully, Accurately and Comprehensively Implementing the New Development Concept, Peaking Carbon Dioxide Emissions and Achieving Carbon Neutrality*.[230] With the promotion of carbon emission reduction by various ministries and commissions, China is vigorously promoting the reform of the energy industry and leading the transition towards clean energy and decarbonization.

In terms of targets, China has pledged to add more than 1,200 gigawatts of solar energy and wind power capacity in the next decade,[231] bringing the installed capacity of clean energy to 2,584 gigawatts by 2030.[232] As a reliable, extensive and long-term industrial goal, renewable energy will present diverse investment opportunities, including capacity expansion of mature technologies, implementation and industrialization of new technologies, clean energy operation and R&D. In this context, a key focus of attention should be on how the construction and operation of renewable energy systems can minimize ecological damage and bring positive value to the environment.

Circular models in the automotive industry

Vehicle lifecycle-management is the biggest business opportunity for promoting the conservation-orientated and circular production model. This opportunity is expected to create $122 billion of commercial value and over 3.7 million jobs by 2030. The circular vehicle lifecycle-management solution covers the whole industry value chain from vehicle manufacturing and use to scrapping, recycling and reuse, with the aim of improving the efficiency of resource use in the automobile industry.

With nearly 400 million motor vehicles, China is one of the largest vehicle markets in the world. Volumes of recycled end-of-life motor vehicles in China are growing, reaching 1,567,000 vehicles as of July 2021, up by 37.8% year-on-year.[233] The automobile remanufacturing market has great development potential. During the 13th Five-Year Plan, China invested more than $250 billion in the renewable resources industry. In 2020, China issued the *14th Five-Year Plan for Circular Economy Development* which proposed to study and formulate a circular vehicle lifecycle-management solution, carry out pilot projects to extend the responsibility to automobile producers, and select regions to take the lead in executing this circular production model for the automotive industry.

Electric bus fleet in China

GETTY/ZSSP

Resource recovery

Improving extraction efficiency is the biggest business opportunity in the nature-positive mineral resources extraction transition, which is expected to create $118 billion of commercial value and 332,000 jobs by 2030. The degree of mechanized extraction of mineral resources in China exceeded 80% in 2020, while the average recovery rate of coal mining areas was 83%.[234] The integration of digital technology into the mineral extraction and supply chain management processes is providing core technical support for a rapid, high-quality transition in this sector. Some Chinese enterprises are using 5G communications for remote control and AI-based unmanned aerial vehicle (UAV) technology for aerial surveying in mineral extraction projects.

End-use steel efficiency

Improving end-use steel efficiency is a great business opportunity in the transition to a conservation-orientated and circular production model. It is expected to create $87 billion of commercial value and 933,000 jobs by 2030. The ways to improve end-use steel efficiency include lightweight design of products in the manufacturing industry, material substitution and steel recycling.

There are three main sources of scrap steel in China:

- Steel mills' own scrap – 21% of total scrap steel in 2018
- Scrap directly from industrial processing (e.g. automobile, machinery, shipbuilding manufacture) – 19%
- Scrap from society (e.g. depreciated or end-of-life machinery and buildings) – 60%

At present, the recovery and processing rates of steel mills' own scrap and industrial scrap steel are high, but the rate for society-produced scrap steel remains low and has much room for improvement.[235]

In 2020, the utilization of scrap steel in China was about 260 million tonnes, replacing the need for approximately 410 million tonnes[236] of iron ore.[237] The *14th Five-Year Plan for Circular Economy Development* set a target for the utilization of scrap steel to reach 320 million tonnes by 2025.[238] As China promotes waste separation, recycling and the circular economy, it will make significant steps towards greater steel recycling and processing.

Metal recycling field in Hong Kong

GETTY/CHUNYIP WONG

5 Conclusion: working together to promote a nature-positive transition

Shenzhen city scenery and skyline

GETTY/BINGFENGWU

The United Nations called 2021 "a crucial year to reset our relationship with nature". It was a year when the whole world was called upon to jointly address the twin crises of climate change and biodiversity loss. The economic and social costs of the COVID-19 pandemic further emphasize the urgent need to invest in nature for a resilient planet that supports human well-being. Accelerating the nature-positive transition of social and economic systems is key to achieving the UN's 2050 vision for biodiversity: "Living in Harmony with Nature."

As we enter a historic decade of action to bend the curve of biodiversity loss and address climate change, scientists, policy-makers and business leaders must join forces to take concrete actions now. This requires global consensus, ambitious policy, stringent regulation, technology and innovation, as well as public and private funding. Businesses can lead the transition by assessing their impacts and dependencies on nature, committing to ambitious goals and setting science-based targets, acting now to avoid, reduce, regenerate, restore, transform and advocate for ambitious government policies.

5.1 Promote global consensus, raise ambition and strengthen collaboration

Deliver the post-2020 Global Biodiversity Framework

In October 2021, the first session of the 15th meeting of the Conference of the Parties to the Convention on Biological Diversity (COP15) was held in Kunming, China. The conference adopted the *Kunming Declaration*, under the theme: "Ecological Civilization: Building a Shared Future for All Life on Earth." In the declaration, leaders from over 100 countries committed to reach an ambitious and transformative global biodiversity agreement and to honour the declaration's 17 commitments. This process has injected strong political impetus and determination into protecting biodiversity and provided a practical roadmap for global environmental governance.

As the host country, China has a key role to play to keep the momentum going for the second phase of COP15, as well as to promote a global consensus and deliver the post-2020 Global Biodiversity Framework. China can lead by raising its own political will and encouraging Chinese businesses to make voluntary climate and nature commitments, take actions and increase their investments in the nature-positive transition. The framework calls for a whole-of-society approach where Chinese leadership on ecological civilization could bring the goals together by strengthening public-private cooperation.

Strengthen cooperation between developing and developed economies

The Chinese government can play an important role in strengthening cooperation between developing and developed economies. Financial support, technology transfer and capacity building are all needed to support developing and transitional economies to protect their biodiversity hotspots, which are among Earth's most biologically rich yet threatened terrestrial ecosystems. The $232 million Kunming Biodiversity Fund committed by the Chinese government to help developing nations protect nature is a first step to ensure the implementation of the biodiversity framework. However, considerable additional finance is still required to close the $700 billion annual biodiversity financing gap.[239]

Promote synergetic cooperation along global value chains

With the deepening of economic globalization, cooperation along global value chains is crucial. Different businesses, regional and country governments can leverage their own competitive advantages and maximize nature-positive synergies through international cooperation in contractual arrangements, joint commitments or place-based coalitions. For example, COFCO International has made a public commitment to zero deforestation in the global soybean and palm oil supply chains, cooperating with various stakeholders including governments, producers, consumers and civil society to reduce the risk of deforestation and land conversion in their agricultural supply chains. By 2019, COFCO International had achieved 100% traceability of all directly harvested soybeans to farms in 25 key cities in the Cerrado Region of Brazil.[240] Chinese companies can also join and leverage the influence of existing multi-stakeholder platforms related to the 15 transitions detailed in this report, such as the Green Infrastructure Investment Coalition and the Platform for Accelerating the Circular Economy.

5.2 Drive policies and regulatory changes

Develop integrated and actionable roadmap

The Chinese government needs to integrate the 17 commitments of the *Kunming Declaration* into its national biodiversity strategy and develop an integrated and actionable roadmap. The government should integrate the concepts of biodiversity conservation and "ecological civilization" into the formulation of its policies, regulations and strategies in all sectors from agriculture and energy to transportation and urban planning. China is now constructing its "1+N" climate policy packages where "1" refers to the template for core guidance to achieve carbon peak and neutrality, and "N" would include the peak carbon action plan by 2030, as well as policy measures and actions in key areas and industries. In the process of designing "1+N" policies, the government needs to mainstream and scale-up nature-based solutions as a key component of its climate action.

Realign incentives and value nature

The Chinese government should carry out a systematic review of its subsidy programmes, identify room for reform, and repurpose any environmentally harmful subsidies. Natural capital accounting techniques such as "diverse conceptualization of multiple values of nature and its benefits" and gross ecosystem product (GEP) assessments and accounting should be promoted, so that businesses and state governments account for natural capital alongside physical, financial and human capital. Tailored public procurement can send clear signals to markets, along with conducive financial policies such as taxation and subsidies to encourage green production and consumption.

Strengthen and standardize disclosure

A growing number of ratings agencies, asset managers, institutional investors and financial institutions are incorporating various environmental, social and governance (ESG) investing approaches. While the rising appetite for sustainable and responsible financing is a welcome development, the government has a key role to play in harmonizing terminologies and frameworks, and in mainstream a common approach. Similar to frameworks that guide companies in the disclosure of climate-related risks, the Taskforce on Nature-related Financial Disclosures allows financial institutions and companies to develop a complete picture of their environmental risks and delivers a framework to standardize nature-related disclosures (see case study below).

CASE STUDY | **Taskforce on Nature-related Financial Disclosures (TNFD)**

The Taskforce on Nature-related Financial Disclosures (TNFD) is new global initiative that aims to deliver a risk management and disclosure framework for organizations to report and act on nature-related risks. The Taskforce consists of 34 senior executives from financial institutions, companies and market service-providers. Members are selected for their individual subject-matter expertise across nature and finance, as well as their sectoral and geographical coverage. It is led by the TNFD co-chairs: David Craig, the former CEO and founder of Refinitiv and Elizabeth Maruma Mrema, executive secretary of the UN Convention on Biological Diversity (CBD).

The TNFD will go through five phases of work from 2021 to 2023: build, test, consult, disseminate and uptake. The TNFD will build upon the structure and foundation of the Taskforce on Climate-related Financial Disclosures (TCFD). It will harness synergies in framework design and stakeholder engagement to avoid repetition and maximize the prospects of accelerated market adoption.

Source: https://www.unepfi.org/news/themes/ecosystems/tnfd-launch/ https://tnfd.global/

5.3 Leverage technologies and innovation

Innovation and technology need to be at the centre of the nature-positive transformation. In particular, the technologies of the Fourth Industrial Revolution have huge potential to be widely applied to the three socio-economic systems addressed in this report.

China's agricultural businesses can strengthen R&D into green inputs, climate-resilient varieties, climate-smart and regenerative agricultural practices and green value-added processing technologies.[241] Under the support of new technologies such as the internet of things, remote sensing, big data, unmanned aerial vehicles (UAVs), robots and artificial intelligence, the agricultural sector can enhance agricultural production efficiency, reduce pollution caused by chemical fertilizers and pesticides, and remotely diagnose animal and plant diseases to prevent and control pests and diseases.

Other technologies such as geospatial analytics, satellite images, cloud computing and visualization techniques help strengthen the monitoring and management of large and medium-sized natural assets on land and in the oceans. Blockchain technology helps register biological and biomimetic intellectual property (IP) assets to record the provenance, rights and obligations associated with nature's assets, thus strengthening transparency in supply chains. When value is assigned to assets, smart contracts could facilitate fair benefit-sharing with the custodians of the asset and for its protection.

Accelerating the construction of new infrastructure such as 5G networks, data centres and blockchain has become the key development strategy in China.[242] Technologies such as 3D printing and building information modelling (BIM) can reduce onsite construction waste and promote its recycling. Advanced geospatial analytics can improve efficiency in the energy and extractives sector. Chinese businesses are already global leaders in many low-carbon technologies such as wind and solar power, electric vehicles and batteries. Smart grids can further improve the coverage of renewable energy while maintaining the stability of power supplies.

Other technologies can help in urban planning and governance. For example, cities can be governed through the integration of government data and social public data. Such innovations and applications require the integrated utilization of public and proprietary data as well as the formulation of effective data governance mechanisms, to support the necessary information exchange and avoid information misuse.

CASE STUDY

Smart agriculture technology improves water-saving and reduces application of pesticides and fertilizers

In the past, pesticides were often sprayed aimlessly over a large area by knapsack-sprayers or tractors. This often led to excessive pesticide use and a waste of water resources. XAG is an agricultural technology company, whose remote sensing drones capture HD images of farmland. The company's agricultural AI system then accurately identifies farmland boundaries, crop density and growth status to determine where pesticides or fertilizers are needed. The AI system also calculates the amount of pesticide or fertilizer required in each area, to form a "prescription map". This process helps farmers to reduce waste. In addition, XAG drones and unmanned ground vehicles conduct autonomous operations in designated areas according to pre-set routes. This avoids repeated spraying and omission, saving pesticide use by 30% and irrigation water by nearly 90% under test conditions. In 2020, precision spraying by XAG agricultural drones saved over 15 million tonnes of water and reduced the use of pesticides by 45,363 tonnes.

Source: XAG *Corporate Social Responsibility Report 2020*, pp.26-27, https://www.xa.com/about/csr.

CASE STUDY

Hangzhou's enterprise "environmental QR code"

Hangzhou has launched an enterprise "environmental QR code" to dynamically reflect the level of enterprise environmental management and risk. The city regularly collects and updates information through its power system monitoring, online complaints system, emergency management, administrative penalties, pollutant discharge permits platform and other business data. After comprehensively analysing the data, the system generates a three-coloured (red, yellow and green) QR code for regulators and society to better monitor enterprises. The environmental QR code has been applied to more than 1,200 enterprises in Hangzhou, of which 92% are green-coded, 5% are yellow-coded and 3% are red-coded enterprises.

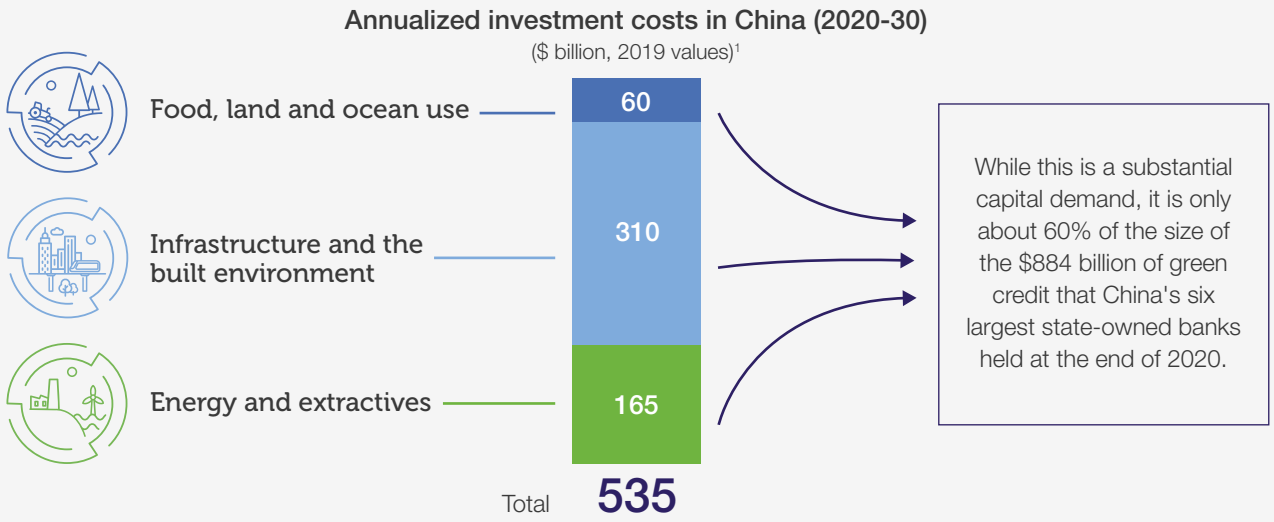
Source: Digital Environmental Protection: "Practice and Exploration of Modernization of Hangzhou's Ecological Environment Management Ability", http://www.hangzhou.gov.cn/art/2020/12/12/art_812262_59021646.html.

TANG MING TUNG/GETTY

5.4 Mobilize public funds and private investment

In addition to reaching a consensus on the way forwards and obtaining policy and regulatory support, these transitions will also require significant capital investment. The adjustment of existing financing models can only facilitate a fraction of the business opportunities identified in this report, which means that new investment is needed to release the great proportion of the commercial value on offer. In order to realize all the business opportunities contained in the 15 transitions across the three major systems, $535 billion will need to be invested every year until 2030. Although this funding gap seems huge, it is equivalent to just 60% of the $884 billion of green credit[243] held by China's six state-owned banks,[244] as at the end of 2020.

FIGURE 14: **Annualized investment costs for the 15 transitions across three systems**



1. Based on estimated investment requirements to capture the business opportunities linked to transitions in each system. Rounded to nearest $5 billion.

Sources: Literature review; Global Sustainable Investment Alliance; AlphaBeta analysis.

> **To realize all the business opportunities contained in the 15 transitions across the three major systems, $535 billion will need to be invested every year until 2030**

In China, the government is required to enable various financial institutions to further expand the scale of their green investment and to innovate social financing methods and broaden financing channels. The government should support the following measures:

- The national green development fund and other key investments should focus on environmental conservation, pollution prevention, ecological restoration, intensive use of energy resources, green transportation and clean energy.
- Banks should enter into strategic cooperation agreements with upstream and downstream enterprises to jointly build sustainable supply-chain finance.[245]
- Insurance agencies should provide coverage for green energy development.
- Fintech companies should facilitate the formation of top-down green consumption patterns among citizens, through the development of relevant products.[246]
- Chinese companies that are "going global" could raise funds through green bonds, climate bonds, sustainability bonds, carbon neutral bonds, sustainability-linked bonds and so on.
- Blended financing is an important mechanism to consider; it uses development financing, support from foundations and other charitable funds to leverage private capital flows.

Some nature-positive businesses require the "ecosystem service payment" mode, which financially compensates the provider of ecosystem services. International payment for ecosystem services is generally consistent with the eco-compensation concept in China. There are three modes of ecosystem service payment:

- **Government procurement**: the government purchases ecosystem services or products from ecosystem service providers on behalf of all people.

– **Market transaction**: the market permits direct transactions between ecosystem service providers and beneficiaries; transaction payments are implemented either according to prevailing mandated rates or at price points determined by market forces.

– **Label certification**: third-party intermediary organizations provide certification or eco-labelling for sustainable products, and consumers pay indirectly for the ecosystem services those products provide, through their voluntary free-market purchasing choices.[247]

5.5 Four steps for business to lead the transition

Business for Nature has developed a four-step approach for businesses to take nature-positive action:

1. **Assess:** Companies should conduct an initial materiality assessment to understand their impacts and dependencies on nature, to ensure they are committing to and acting on the most material ones. Companies should expand their assessment to include nature, climate and people where possible.

2. **Commit:** Companies should make meaningful, informed and public commitments through credible platforms. Monitor, report and improve on progress towards commitments and targets, and use best-practice ESG (environmental, social and governance) metrics, making sure to incorporate relevant contextual information (such as the population density where air pollution occurs). Take inspiration from the Science-Based Targets for Nature (SBTN) initial guidance and interim targets, and prepare to set targets in line with the final guidance to be released in 2022.

3. **Act:** Companies should systematically apply the mitigation hierarchy within and beyond corporate operations to reduce pressures on nature and to ensure positive contributions across value chains, following the AR3T framework proposed by SBTN:

   – ***A**void and **R**educe* the pressures on nature loss

   – ***R**estore and **R**egenerate* ecosystems including forests, soils, freshwater systems and marine environments so that the state of nature can recover

   – ***T**ransform* underlying systems, at multiple levels, to address the drivers of nature loss

4. **Advocate:** Companies should call on governments to adopt policies which create a stable operating environment and level playing field for business. Contribute to key negotiations for nature, for example, at the UN Convention on Biodiversity's COP15 Part 2 in 2022. Support specific business advocacy initiatives that contribute to reversing the loss of nature. Leverage corporate influence by collaborating on shared platforms to drive change. For example, more than 1,000 companies worldwide with total revenues of $4.7 trillion, including Chinese companies such as COFCO International, Fosun International, JD and Tencent Holdings, have joined the Tencent Holdings, have joined the "Nature Is Everyone's Business" call to action urging governments governments to adopt policies now to reverse nature loss in this decade.

5.6 Conclusion

We are fast approaching irreversible tipping points in climate and natural ecosystems. China's best chance to achieve this transition is through building consensus around the need to strengthen policy and supervision, introduce more investment and financial support, and use technology and innovation levers to usher in a carbon-neutral, nature-positive future.

The cost of inaction on nature loss is too high to ignore. The time is ripe for business leadership. Companies that act now can reap the economic benefits of increasing their resilience, enhancing strategic business advantage and securing long-term value creation.

This report integrates the three socio-economic systems and 15 transitions identified in the World Economic Forum's *New Nature Economy Report II: The Future of Nature and Business* with China's development status and trends, and connects them to industries under China's national economic industries classification. We look forward to further exploring this important agenda, deepening our understanding under this framework and continuing this meaningful work in future reports.

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Authors

World Economic Forum
Zhu Chunquan, China Head of Centre for Nature and Climate

Akanksha Khatri, Head of Nature Action Agenda

Susan Hu, Specialist, Nature Action Agenda

Lu Xinqing, Champions for Nature Community Specialist, Nature Action Agenda

Alexia Semov, Community Lead, Food and Nature Initiative

Zhang Peilin, Intern, Nature-Based Solutions Platform

GoldenBee Management Consulting Co. Ltd.
Yin Gefei, Chief Expert

Wang Ying, Senior Manager

Yang Shihui, Senior Manager

Wang Qian, Consultant

He Qian, Consultant

Liu Xianrong, Consultant

Wang Xia, Consultant

Wang Xingli, Consultant

Hai Yuan, Consultant

Editing and design
Jonathan Walter, Editor

Jean-Philippe Stanway, Graphic designer

Amy Li, Chinese editor

Benedicte Chung, Editor, Communications INC

Contact

For questions about the *New Nature Economy Reports* series, contact:

Akanksha Khatri (akanksha.khatri@weforum.org)

Alexia Semov (alexia.semov@weforum.org)

Lu Xinqing (xinqing.lu@weforum.org)

For questions about this report, contact:

Zhu Chunquan (chunquan.zhu@weforum.org)

Susan Hu (susan.hu@weforum.org)

Experts consulted

Thanks also go to the many leading academic, industry, NGO and government experts who provided invaluable perspectives, listed below in alphabetical order:

Justin Adams, Co-director, Nature-Based Solutions, World Economic Forum

Chen Cai, Director & Senior Engineer, Information Technology Application Research Department, Institute of Industry and Planning, China Academy of Information and Communications Technology

Dimitri de Boer, Chief Representative, ClientEarth, China Office

Eva Zabey, Executive Director, Business for Nature

Fan Shenggen, Chair Professor, China Agricultural University

Fang Li, Country Director, World Resources Institute China

Huo Li, Deputy Director, Corporate Engagement, The Nature Conservancy

Shivin Kohli, Manager, AlphaBeta – an Access Partnership company

Li Feng, Director & Professor, Department of Landscape Architecture and Ecological Restoration Research Centre, School of Architecture, Tsinghua University

Li Junsheng, Director & Research Professor, Institute of Ecology, Chinese Academy of Environmental Sciences

Li Xuemei, Professor, School of Economics and Management, Beijing Jiaotong University

Li Zhong, Director, Institute of Spatial Planning & Regional Economy, National Development and Reform Commission, China

Liu Jingru, Research Professor, Research Centre of Ecological and Environmental Sciences, Chinese Academy of Sciences

Liu Rui, Researcher, Institute of Food and Nutrition Development, Ministry of Agriculture and Rural Affairs

Lu Lunyan, Country Representative, World Wide Fund for Nature (WWF), Beijing Office

Lucy Coast, Communications Director, Business for Nature

Luo Ming, Deputy Director General, China Land Consolidation and Rehabilitation Centre, Ministry of Natural Resources of China

Joyce Ma, China Country Director, The Nature Conservancy

Ouyang Zhiyun, Director General & Research Professor, Research Centre of Ecological and Environmental Sciences, Chinese Academy of Sciences

Qin Xue, Deputy Director, Corporate Engagement, The Nature Conservancy

Ren Xiyan, Senior Engineer, China Academy of Urban Planning and Design

Nicole Schwab, Co-director, Nature-Based Solutions, World Economic Forum

Sun Lihui, Director, Development Department, China Chamber of Commerce of Metals, Minerals & Chemicals Importers & Exporters

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Yan Dongquan, Director-General, Ecology and Resource Conservation Station, Ministry of Agriculture and Rural Affairs of China

Yang Chunping, Director-General, Circular Economy Research Office, Institute of Economic Institutions and Management, National Development and Reform Commission, China

Yao Lin, Associate Research Professor, Chinese Academy of Natural Resources Economics

Yu Zhihong, President & Editor-in-Chief, China Sustainability Tribune

Zhang Xinan, President & Research Professor, Chinese Academy of Natural Resources Economics

Zhang Yan, Country Coordinator, International Union for Conservation of Nature (IUCN) China

Zheng Miaozhuang, Associate Research Professor, China Institute for Marine Strategy, Ministry of Natural Resources of China

Zhou Hongchun, Former Director-General & Research Professor, Social Development Research Department, Development Research Centre for the State Council of the People's Republic of China

Endnotes

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World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org